Deloro Village Environmental Health Risk Study

Final Report

GOSS GILROY INC.

Management Consultants

Conseillers en gestion

Deloro Village Environmental Health Risk Study
Final Report

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Executive Summary

Overview. This report documents the results of an environmental health risk study of Deloro residents and a comparable (control) community. The study surveyed all Deloro, Ontario residents and a comparative sample of control (unexposed) community residents from Havelock, Ontario. The study was carried out by Goss Gilroy Inc. with the actual survey of residents taking place during September, October and November, 1998.

Study Population. Deloro is located just north of Highway 7 on the Moira River, north of Belleville. At the time of the study, there were approximately 70 residences in Deloro, and a population of about 150, including about 40 children aged 15 years and under. This study is a component of a larger study undertaken by the Ontario Ministry of the Environment in the Village of Deloro. The study is a direct result of a screening level assessment conducted by the MOE in 1998, in which *"it was concluded that there was sufficient evidence to warrant a more comprehensive evaluation of exposure and potential risk to residents."*

Purpose. The purpose of the study was to establish the potential exposure of Deloro's residents through biological monitoring of urinary arsenic in community residents, together with the administration of an environmental health risk questionnaire and analysis of the collected data. Specific objectives of the study were:

- to compare the level of arsenic in urine for residents of Deloro with a comparable (control) community that did not have any identifiable source of arsenic contamination;

- to collect, analyze and profile data on the socio-demographics, health and environment characteristics and diet patterns of the residents of Deloro with a comparable community - through the use of an environmental health risk questionnaire;

- to prepare the collected data on the residents of Deloro and the control community for use in the modelling component of the overall project; and,

- if individuals are observed who exhibit elevated urinary arsenic and if sample size is large enough to provide for sufficient statistical power (e.g., 80% chance of detecting a 9-14% difference in average arsenic levels in two subpopulations), undertake a quantitative analysis of risk factors, testing specific hypotheses of association between urinary arsenic and levels in environmental media.

Urine Collection and Testing. Urine samples were collected from participants using standard medical protocols and rigorous quality assurance methods. All testing of urine samples was completed by MAXXAM Analytics Inc., Occupational Health Sciences Lab (Etobicoke, Ontario), a certified laboratory. Each sample was tested for total arsenic (organic and inorganic forms), speciated arsenic (inorganic forms: As(III), As(V), MMA, DMA), and creatinine. A method detection limit of 6 μg/L was used which is well below the normal range levels and was appropriate for this study. Lower detection limits although achievable, were unnecessary. The protocols in accordance with Ministry of Health

requirements were developed by MAXXAM and reviewed by Goss Gilroy and the MOE scientific experts.

Measurements of arsenic in urine was conducted in the fall of 1998 at the time when dust exposures were anticipated to be generally high and dry conditions exist. This was to capture the high possible exposures. Arsenic in urine was selected as the best method to measure recent exposures because it is sensitive to low levels of exposure, is comparable to results in other similar studies and because there are existing criteria against which the health importance of the finding can be interpreted.

Environmental Health Risk Interview Questionnaire. The interview questionnaire was developed using previously tested questions from former health risk questionnaires. Areas covered by the questionnaire include: occupational information; demographics; children's physical environment; diet patterns; health and medication usage; and, household physical characteristics.

Ethical Considerations. All respondents aged sixteen years and older signed a consent form before participating in the study. For children under sixteen years of age, a parent or guardian signed a consent form before participating in the study. The consent form described the purpose of the study and outline issues of confidentiality.

Data Analytic Methods. The study targeted all households and residents in the village of Deloro. All participants were requested to give a first morning urine sample. An environmental health risk questionnaire was administered to each household, which collected the requisite information.

Havelock was chosen as the comparison (control or unexposed) community as it met several predetermined criteria, such as being a similar rural community, nearby, and does not have an identified point source of arsenic contamination. A random sample of individuals from this community was included in the survey. In total, a sample of 21 households with 54 residents (41 adults and 13 children) were selected from Havelock to match the age distribution of the Deloro residents. All households/residents were administrated a similar environmental health risk questionnaire as conducted in Deloro and requested to give a first morning urine sample. Detailed comparisons were then made on all collected variables.

Results

Of the 68 targeted households (a census of Deloro's households), 55 households (81%) agreed to participate in the study. The 140 respondents were comprised of 103 adults and 37 children aged 15 years and under. Based on the number of respondents per residence contacted, the total number of participating residents (140) represents at least 80% of the total population of Deloro.

With respect to urinary sampling, of the 55 participating households in Deloro, 53 (96%) households participated in this sampling. In total, 121 (86%, 121/140) of the participating Deloro residents had submitted urine samples. Therefore, with respect to coverage, the

following results present a statistically precise picture of the levels of urinary arsenic and other risk factors in the Deloro population.

Of the 54 selected residents of the comparison (control) community of Havelock, 53 residents (98%, 53/54) supplied a urine sample as requested, an excellent response rate.

Urinary Arsenic. It has been acknowledged in the literature that much of the total arsenic could be a measure of exposure to organic sources (e.g., seafish meal) and these possess no danger to the health of the person. *Speciated (inorganic) arsenic,* identified in the literature as potential cause for concern, at least with respect of some acute symptoms and some chronic diseases, were detected in a very few of the respondents. *It was this latter measure that was the main focus of the urinary arsenic analysis.*

Deloro-Havelock Comparisons for Urinary Arsenic. ***Overall, the respondents from Havelock had similar urinary arsenic results to those results from Deloro*** - that is,

- for *speciated* arsenic (the main focus of the study), the *mean/standard deviation* urinary arsenic were *4.57/3.98 μg/L* respectively for 53 Havelock residents, and for Deloro, *4.36/4.00 μg/L* respectively for 121 Deloro residents. Similar results were obtained for all age groups.

Similar urinary arsenic results were obtained from the *total* arsenic comparisons between Havelock and Deloro, except that all the Havelock respondents had *total* arsenic well below the 150 μg/L observed for two individuals from Deloro (see *Follow-up of Residents* below for further details).

The average levels of urinary arsenic of residents (both for *speciated* and *total*) from Deloro and Havelock were much less than the averages reported for other people exposed to significant sources of arsenic (such as mining, smelting, occupational, etc.) as reported in the scientific literature.

Follow-up of Residents. Two of the Deloro respondents showed a level of *total* arsenic above 150 micrograms per litre of urine. These values are above the normal range levels used by physicians when screening for acute arsenic poisoning. These persons were advised to visit their family physician for a subsequent test to verify the levels of arsenic in their urine and to take any action to reduce these levels if necessary.

Three other residents (two in Deloro, one in Havelock) had levels of *speciated* urinary arsenic 20 micrograms per litre of urine or greater, and they too were advised to visit their family physician for subsequent testing to verify the levels of arsenic in their urine, and to take any actions to reduce these levels if necessary. The normal range level for *speciated* urinary arsenic is a subject of much international research today, and some experts have suggested a normal range level of 25 μg/L. Although no resident in the Deloro/Havelock study exceeded 25 μg/L, it was deemed prudent to invoke follow-up procedures nevertheless. In addition, comprehensive information packages were provided to each individual family physician.

In summary with respect to all of these follow-ups, ***it is emphasized that none of the five respondents - who were advised to seek additional testing by their family physicians, showed any adverse health effects or unusual exposure to other environmental or dietary factors, based on their responses to the health risk questionnaire.*** In other words, there was nothing "unusual" about these five individuals as far as the data that were collected in this study. No relationships to reported adverse health effects or other potential risk factors could be identified.

Statistical Comparisons and Conclusions. Statistical comparison of the frequency distributions of urinary arsenic levels (*total* and *speciated*) and statistical tests of mean and median urinary arsenic levels showed no significant differences at the 5% significance level. ***It is therefore reasonable to conclude that residents of Deloro do not appear to have, on average, higher levels of arsenic (total and speciated) than the comparison (control) community.***

Mean urinary arsenic levels (total as well as speciated) were compared for people reporting various health problems in the last year and these were found to be not significantly different. ***It is therefore reasonable to conclude that the levels of arsenic in Deloro are not indicative of any excess levels of morbidity as observed by their self-reports.*** The health problems reported in Deloro were similar to those reported from Havelock and appear similar to the general population.

Regression analysis showed that the urinary arsenic levels (total and speciated) could not be statistically associated with the characteristics of the population. Socio-demographic variables such as age, income and education were similar for various levels of urinary arsenic. None of the regression coefficients were significant.

Characteristics of the places of residence, including the presence of vegetable garden and use of well water as well as length of residence in Deloro were also analyzed using a linear regression. None of the regression coefficients were statistically significant.

The respondents with higher levels of arsenic were compared to those with lower levels and none of the variables showed significant association. Since there was no overall difference in mean arsenic levels between Deloro (exposed community) and Havelock (unexposed community), this result was expected.

Normally, in statistical modelling, various subgroups of independent variables are investigated separately and the ones found to be significant considered together in a final model. In this analysis, ***since none of the separate regressions resulted in significant associations, a final model incorporating all the variables considered was not done.***

Overall Conclusions

There were no statistical difference in levels of arsenic in urine between Deloro and the comparison (control) community of Havelock. Also, the levels of distribution of arsenic in urine in Deloro residents were very similar to those of Havelock.

The levels of arsenic in urine in Deloro are not indicative of any excess levels of illness (as observed by the Deloro/Havelock residents self-reporting).

There was no demonstrable relationship between arsenic levels in residential yards and garden soil and arsenic levels in urine.

1.0 Introduction

This report documents the results of an environmental health risk study of Deloro residents and a comparable (control) community. The study surveyed all Deloro, Ontario residents and a comparative sample of control (unexposed) community residents from Havelock, Ontario. The quantitative results presented herein show the potential arsenic exposure of Deloro's (and Havelock) residents through biological monitoring of urinary arsenic in community residents, together with the administration of a health risk questionnaire and analysis of the collected data.

The study was undertaken by Goss Gilroy Inc., an Ottawa-based consulting firm. The study was carried out during the second half of 1998, with the actual survey of residents taking place during September, October and November, 1998.

The environmental health risk study is a component of a larger study being undertaken by the Ontario Ministry of the Environment in the Village of Deloro. The study is a direct result of a screening level assessment conducted by the MOE in 1998, in which *"it was concluded that there was sufficient evidence to warrant a more comprehensive evaluation of exposure and potential risk to residents."*

Deloro is located just north of Highway 7 on the Moira River, north of Belleville. There are approximately 70 residences in Deloro, and a population of about 150, including about 40 children aged 15 years and under. Previous surveys noted in the Terms of Reference for the study have found that the soil in the Village is *"significantly contaminated with arsenic and cobalt (i.e., exceeds provincial clean-up guidelines) and marginally contaminated with lead, nickel and silver (above Ontario background levels)."* Also, there are concerns regarding the processing and disposal of radioactive materials and the presence of radon gas in the community.

In addition to this introductory section, the report consists of the following sections:

- Section 2.0, describing the purpose of the study and providing the study objectives;
- Section 3.0, providing the study approach including the description of sites, collection of urine samples, implementation activities, urine testing, interview questionnaire, ethical considerations and data analytic methods;
- Section 4.0, describing the results of the survey analysis; and,
- Section 5.0, provides a discussion of the results with conclusions.

Several Appendices are attached. They provide supporting technical material to this report.

2.0 Purpose of the Study

This study was undertaken as part of a larger study being undertaken by the Ontario Ministry of the Environment in the Village of Deloro, directly following a screening level assessment conducted by the MOE in the first half of 1998. The purpose of the study was to establish the potential exposure of Deloro's residents through biological monitoring of urinary arsenic in community residents, together with the administration of an environmental health risk questionnaire and analysis of the collected data.

2.1 Specific Objectives

The specific objectives of this study are three-fold; namely,

- to compare the level of arsenic in urine for residents of Deloro with a comparable (control) community that did not have any identifiable source of arsenic contamination;
- to collect, analyze and profile data on the socio-demographics, health and environment characteristics and diet patterns of the residents of Deloro with a comparable community - through the use of an environmental health risk questionnaire;
- to prepare the collected data on the residents of Deloro and the control community for use in the modelling component of the overall project; and,
- if individuals are observed who exhibit elevated urinary arsenic and if sample size is large enough to provide for sufficient statistical power (e.g., 80% chance of detecting a 9-14% difference in average arsenic levels in two subpopulations), undertake a quantitative analysis of risk factors, testing specific hypotheses of association between urinary arsenic and levels in environmental media.

3.0 Study Approach

3.1 Collection of Urine Samples and Quality Assurance Methods

Urine samples were collected from participants using the protocol outlined in Appendix A. The protocols were developed by our team's nurse based on current methods. Main considerations were:

- samples were collected from the first voiding of the morning;
- samples were kept cool using ice packs and cooler bags until collected by the field team;
- glacial acetic acid was added to each sample within five hours;
- at least 35 ml of urine was collected for each sample; and,
- samples were refrigerated after collection until analysis.

3.1.1 Implementation Activities

All implementation activities in the field were preceded by and based on formal procedures and team training. One aspect of the field team training was to ensure that the interviewers were able to explain the process of urine sampling to at least one adult in each household. Guide sheets describing the urine collection process for the different age groups (infants, children and adults) were left with participants along with the necessary sample collection equipment. After conducting the health risk interview, the interviewer would review the urine collection process and leave the collection kit. A field team member then collected the samples the following morning.

All field data collection activities for Deloro and Havelock were carried out over the time period September 24th to October 17th, and November 5th to 16th, 1998, respectively.

3.1.2 Urine Testing

Urine samples were collected using standard medical protocols. All testing of urine samples was completed by MAXXAM Analytics Inc., Occupational Health Sciences Lab (Etobicoke, Ontario), a certified laboratory. Each sample was tested for total arsenic (organic and inorganic forms), speciated arsenic (inorganic forms: As(III), As(V), MMA, DMA), and creatinine. A method detection limit of 6 μg/L was used which is well below the normal range levels and was appropriate for this study. Lower detection limits although achievable, were unnecessary. The protocols in accordance with Ministry of Health

requirements were developed by MAXXAM and reviewed by Goss Gilroy and the MOE scientific experts.

Measurement of arsenic in urine was conducted in the fall of 1998 at the time when dust exposures were anticipated to be generally high and dry conditions exist. This was to capture the high possible exposures. Arsenic in urine was selected as the best method to measure recent exposures because it is sensitive to low levels of exposure, is comparable to results in other similar studies and because there are existing criteria against which the health importance of the finding can be interpreted.

3.2 Interview Questionnaire

The interview questionnaire was developed using previously tested questions from former health risk questionnaires. Areas covered by the questionnaire include:

- Occupational information;
- Demographics;
- Children's physical environment;
- Diet Patterns;
- Health and medication usage; and,
- Household physical characteristics.

The complete version of the interview questionnaire is contained in Appendix B. Other relevant documents are given in Appendix C.

3.3 Ethical Considerations

All respondents aged sixteen years and older signed a consent form before participating in the study. For children under sixteen years of age, a parent or guardian signed a consent form before participating in the study. The consent form described the purpose of the study and outlined issues of confidentiality. Complete versions of the consent forms are contained in Appendix D.

3.4 Data Analytic Methods

The study targeted all households and residents in Deloro village. All participants were requested to give a first morning urine sample. An environmental health risk questionnaire was administered to each household, which collected information on socio-demographics, health and environment characteristics and diet patterns.

The following criteria were used to choose a comparison (control) reference community:

- be within same geographic region as Deloro (approximately, 100 km radius);
- not be on the Moira River/Lake waterway system;
- have no known possible source of arsenic contamination; and,
- have socio-demographic characteristics similar to Deloro.

Havelock met these criteria and was chosen as our control community. Note that Havelock was sufficiently distant from Deloro to not be affected by any potential dust arising from the site in Deloro, yet close enough to "help" a familiar neighbour by participating in our sample fieldwork and urine sampling. Nevertheless, to ensure that any potential confounders in the Havelock sample were addressed (e.g., having eaten fish from Moira Lake; previously worked in the Deloro mine; work with chemicals), similar questions were asked of Havelock residents as those used in the Deloro study. Detailed comparisons would then be made on all collected variables.

In total, a sample of 21 households with 54 residents (41 adults and 13 children) were selected from Havelock to match the age distribution of the Deloro residents. This matching was based on prior census reports, using three broad age groups: birth to 15 years, 16 to 39 years and over 40 years of age. All households/residents were administered a similar environmental health risk questionnaire as conducted in Deloro and requested to give a first morning urine sample.

Collected data were tabulated by SPSS (version 8). Statistical comparisons, where applicable, were done using the same program. For example, we examined the correlations between urinary arsenic levels, environmental factors, and health effects collected in the questionnaire. In addition, we investigated the hypothesis of association between urinary arsenic and levels in the environmental media identified on the questionnaire (e.g., source of drinking water, backyard garden vegetables, fish diet). However, most of the data collected was used for the modeling component of the project, done by other contracted

team members - who used all environmental media (including soil, indoor air and dust, outdoor dust, outdoor air, drinking water) in their environmental health risk models.

Descriptive statistics of various questions and levels of urinary arsenic are provided. Comparison of results from Deloro with the results from Havelock are made where appropriate. Frequency distributions (histograms) and box plots of the urinary arsenic levels for the two communities are presented and compared. Parametric analysis of variance and non-parametric Mann Whitney tests were done to evaluate the differences in mean and median arsenic levels respectively. Validity of these tests are also discussed.

Although the qualitative review did not indicate a need for further analysis, due to the comprehensive nature of the project, the Technical Steering Committee felt that it would be prudent to do further quantitative (multivariate) and robust analysis (sections 4.5 and 4.6).

Goss Gilroy's Memo (dated July 12, 1999) outlines GGI's response to reviewers' comments on the study. This Memo is attached as Appendix E.

4.0 Results

4.1 Response Rates

Deloro. Of the 68 targeted households (a census of Deloro's households), 55 households (81%) agreed to participate in the study. Four households (6%) refused to participate in the study and 8 (12%) households could not be contacted despite repeated attempts. The 140 respondents were comprised of 103 adults and 37 children aged 15 years and under. In total, 140 of all residents in Deloro participated in some part of the survey (urinary sampling/environmental health risk questionnaire). Based on the number of respondents per residence contacted, the total number of participating residents (140) represents at least 80% of the total population in Deloro.

With respect to urinary sampling, of the 55 participating households, 53 (96%) households participated in this sampling. Only two households refused to give urine samples, and in 14 households, only some members gave urine samples. In total, 121 (86%, 121/140) of the participating residents had submitted urine samples.

Havelock. The targeted sample of 21 households had 54 residents, consisting of 41 adults and 13 children aged 15 years and under. Of these, 53 residents (98%, 53/54) supplied a urine sample as requested. Urine sample could not be obtained for one preschooler.

4.2 Comparison of Arsenic Levels in Deloro and Havelock

4.2.1 Total Arsenic

Table 1a gives the mean urinary arsenic, As (in micrograms/litre of urine : μg/L), for total As of residents of Deloro and Havelock.

Many of the residents had arsenic levels below the level of detection. Two separate analysis were done to take into account the possible true levels of As for these people. We first assumed their levels to be 3 μg/L (half the level of detection) and then assumed the lowest level to be 0. Comparison of mean levels of As is similar under both these conditions.

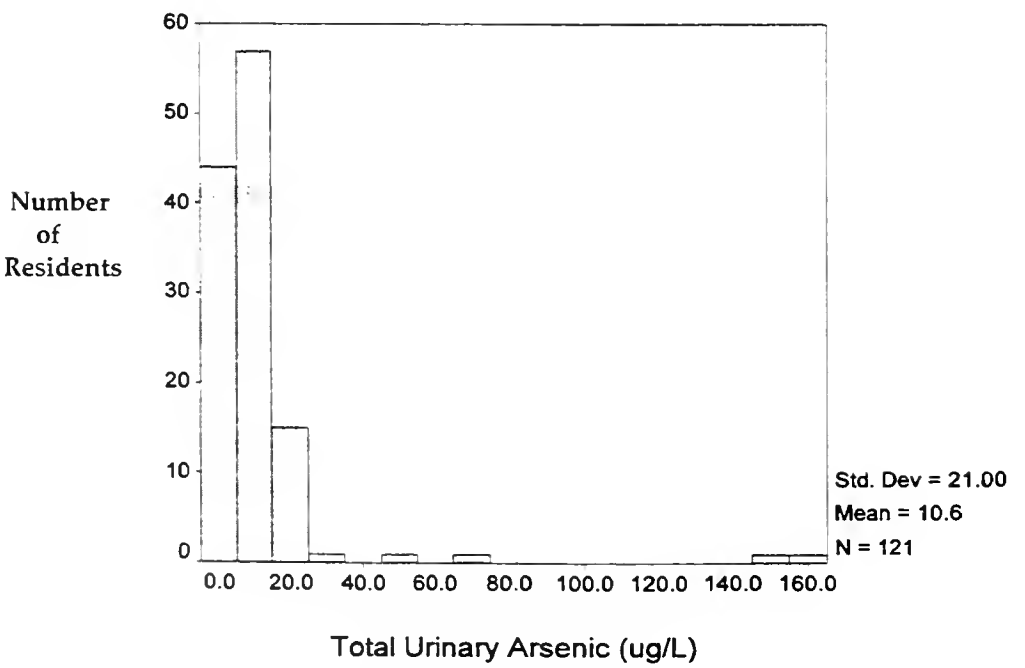
The standard deviation for Deloro is much higher than that for Havelock. This is due to two Deloro residents with levels above 150 μg/L. As is evident from **Table 1a**, there is no evidence of increased mean levels of As in Deloro, compared to Havelock. Statistical test of the hypothesis of equal mean for the two communities leads to the same conclusion.

Table 1a: Total Urinary Arsenic ($\mu g/L$) of Residents of Deloro and Havelock

	Assuming Non-detectable As as 3 $\mu g/L$		Assuming Non-detectable As as 0 $\mu g/L$	
	Deloro	Havelock	Deloro	Havelock
Mean	11.67	7.65	10.58	6.09
Range	3 - 158.03	3 - 33.01	0 - 158.03	0 - 33.01
Std. Dev.	20.49	6.56	21	7.77
n	121	53	121	53

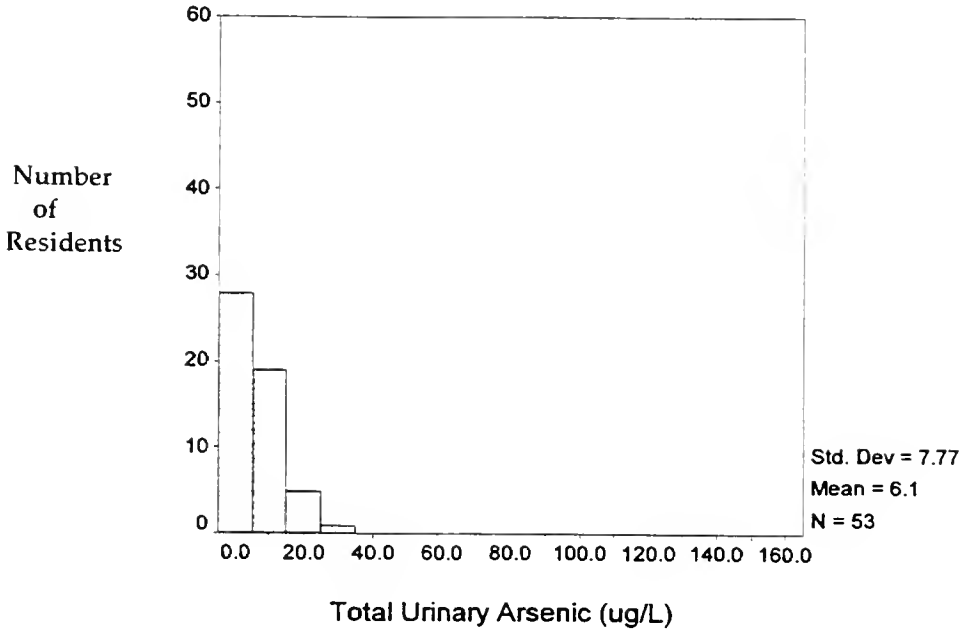
The frequency distributions (histograms), **Figures 1 and 2**, and the box plots **(Figure 3)** for total urinary arsenic in Deloro and Havelock are presented below. The box plots, in particular, show the close similarities in the distributions of total urinary arsenic of the residents of Deloro and Havelock. The overlapping confidence intervals for the two distributions indicate that there is no statistical difference in the means between Deloro and Havelock. The symbols (o,*) in figures 3a and 3b represent the highest values.

Figure 1: Frequency Distribution for Total Urinary Arsenic of Residents in Deloro*



* assuming non-detectable As as 0 $\mu g/L$

Figure 2: Frequency Distribution for Total Urinary Arsenic of Residents in Havelock*



* assuming non-detectable As as 0 μg/L

Figure 3a: Box Plots of Total Urinary Arsenic of Residents in Deloro and Havelock (assuming non-detectable As as 0 μg/L)

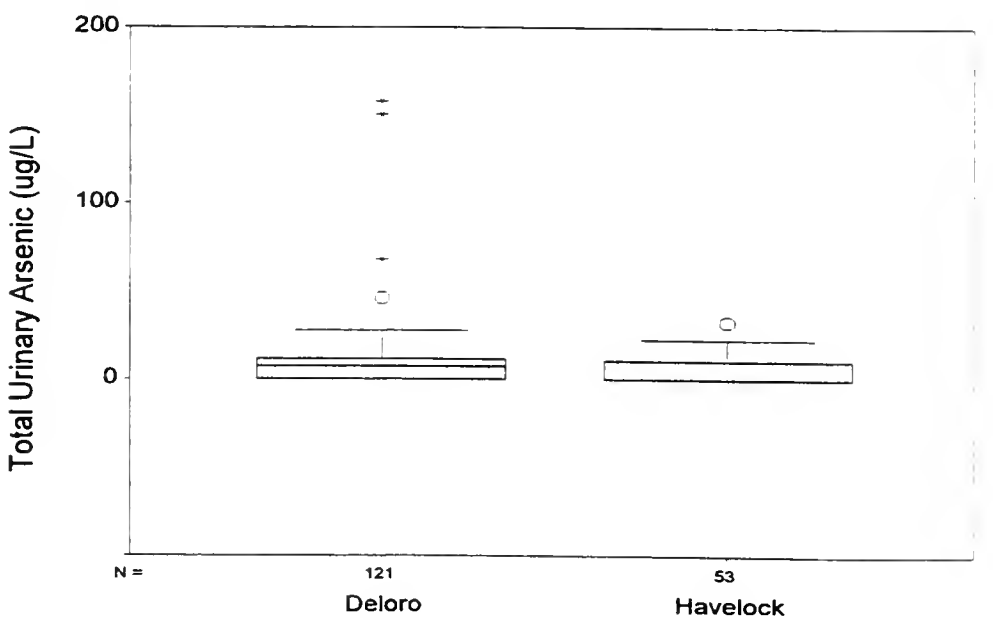
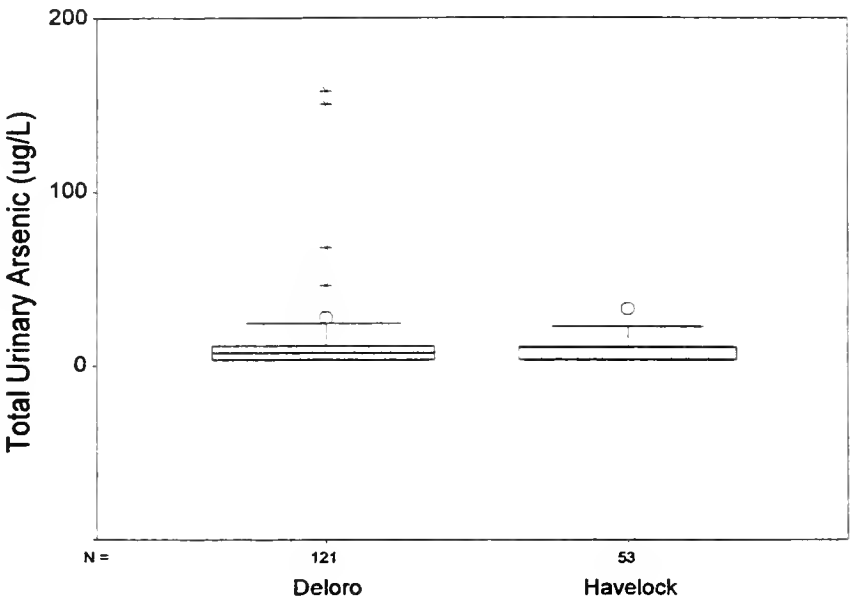


Figure 3b: Box Plots of Total Urinary Arsenic of Residents in Deloro and Havelock (assuming non-detectable As as 3 μg/L)



Comparison of mean urinary arsenic levels using the Student's t-test shows that the difference is not statistically significant (P>0.05). Since the frequency distribution for Deloro is highly skewed, a non-parametric test (Mann-Whitney U-test) was also done, to compare the median arsenic levels between Deloro and Havelock. This was also not statistically significant (P>0.05).

A separate analysis using only the results for residents with detectable levels of As is presented in **Table 1b.** Again, similar results are found, with no statistical evidence of increased mean levels of As in Deloro compared to Havelock.

Table 1b: Total Urinary Arsenic (μg/L) for Residents of Deloro and Havelock with Detectable Levels of As Only

	Deloro	Havelock
Mean	16.63	12.86
Std. Dev.	24.39	6.3
n	77	25

If we remove the two Deloro residents with total urinary arsenic values above 150 μg/L from the comparative analyses (i.e., treating these high As levels as statistical outliers), the Deloro-Havelock results are much closer (see **Table 1c**). The differences are not statistically significant (P>0.05) by the parametric or the non-parametric tests.

Table 1c: Total Urinary Arsenic (μg/L) for Residents of Deloro and Havelock Excluding the Two Deloro Residents with Levels Above 150 μg/L

	Deloro	Havelock
Mean	12.96	12.86
Std. Dev.	9.26	6.3
n	75	25

The environmental/health characteristics of these two excluded Deloro residents are examined separately (further details are given below) to see if they have any reported adverse health events or other risk factors. Also, their levels of speciated (inorganic) As were also compared to the rest of the group. These values were well within the range of values for the group.

Although the sample sizes are quite small, statistical comparisons were carried out on the total urinary arsenic data for the children (12 years and under) and youth (13 to 19 years inclusive) in Deloro and Havelock. **Table 1d** summarizes the total urinary arsenic for the children/youth Deloro-Havelock comparisons, while **Figures 4, 5, and 6** show the related frequency distributions (histograms) and box plots. As can be seen by these Figures, the children/youth distributions for Deloro-Havelock are similar to what was observed for the entire study samples.

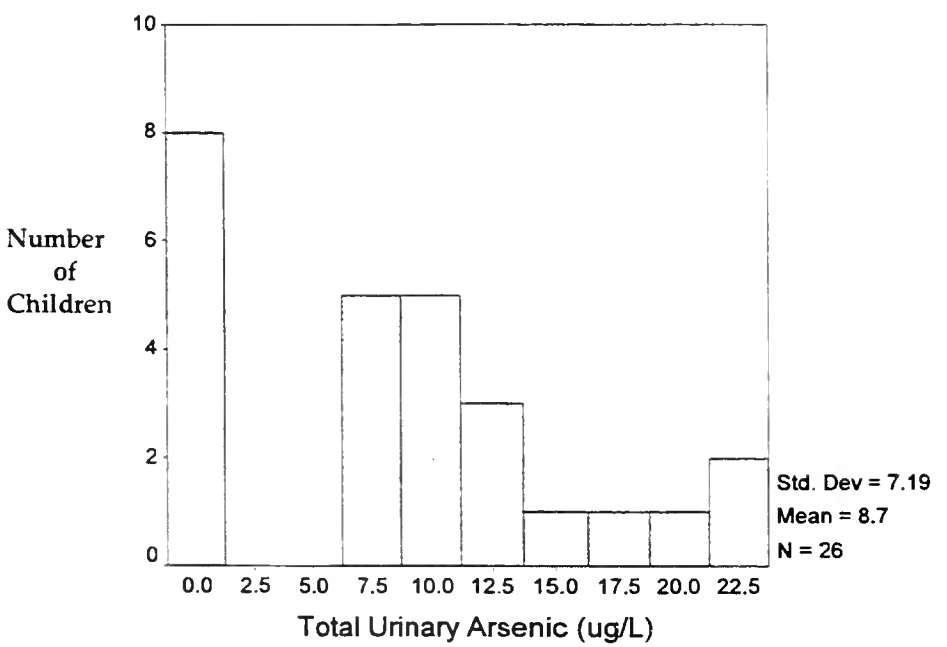
One anomalous (total urinary arsenic) value from Deloro was excluded from the children/youth summary statistics. It was considered a statistical outlier and the removal of this value made the statistical comparisons more appropriate. Its inclusion was not a problem for the box plots, and all data values are shown therein. Furthermore, statistical comparisons of means (e.g., t-test of means) for Deloro and Havelock were done for the children/youth data with and without the outlier in the data analysis, and no statistically significant differences (P>0.05) were found in both instances.

Table 1d: Total Urinary Arsenic (μg/L) of Children/Youth of Deloro and Havelock*

	Assuming Non-detectable As as 3 μg/L				Assuming Non-detectable As as 0 μg/L			
	Deloro		Havelock		Deloro		Havelock	
	Children	Youth	Children	Youth	Children	Youth	Children	Youth
Mean	9.58	11.44	9.27	9.29	8.66	10.94	8.14	8.09
Range	3 - 23.75	3 - 21.11	3 - 20.29	3 - 21.62	0 - 23.75	0 - 21.11	0 - 20.29	0 - 21.62
Std. Dev.	6.09	6.82	6.42	7.71	7.19	7.62	7.73	9
n	26	6	8	5	26	6	8	5

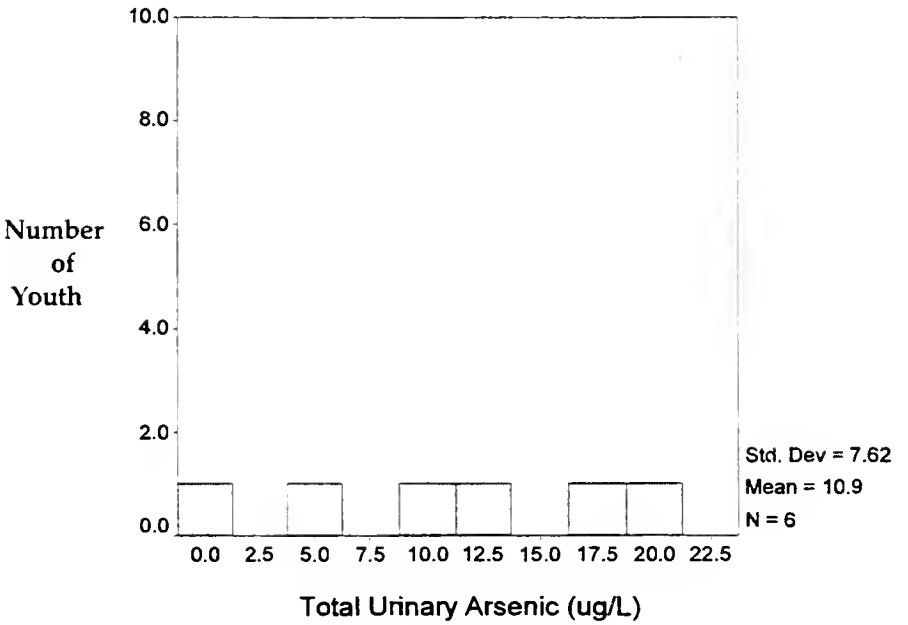
* children defined as ≤ 12 years of age.
youth defined as 13 - 19 years of age inclusive.
Note: anomalous value of 158.03 excluded from Deloro calculations (see text for details).

Figure 4a: Frequency Distribution for Total Urinary Arsenic of Children (≤ 12 years) in Deloro*



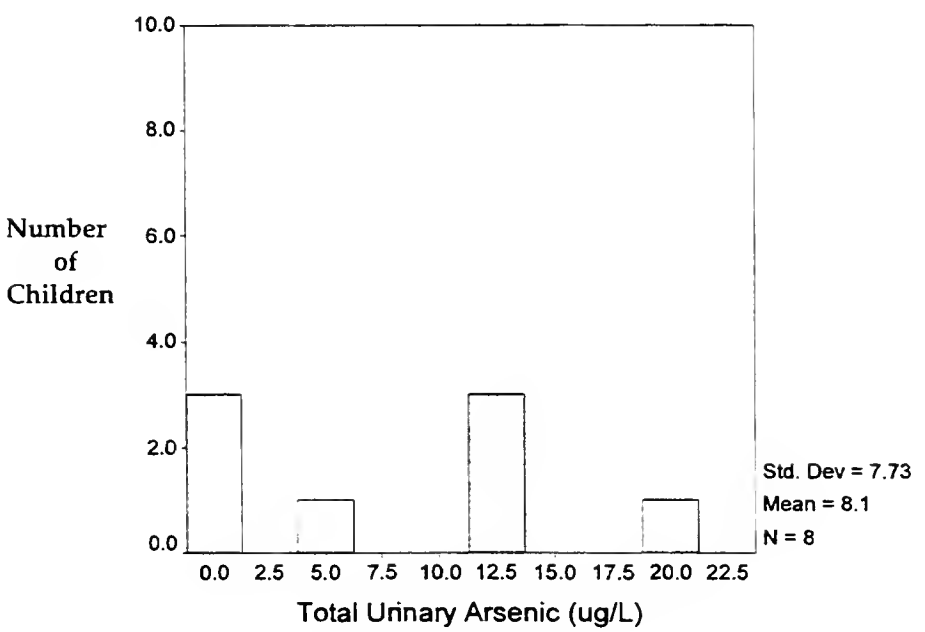
* assuming non-detectable As as 0 μg/L

Figure 4b: Frequency Distribution for Total Urinary Arsenic of Youth (13 - 19 inclusive) in Deloro*



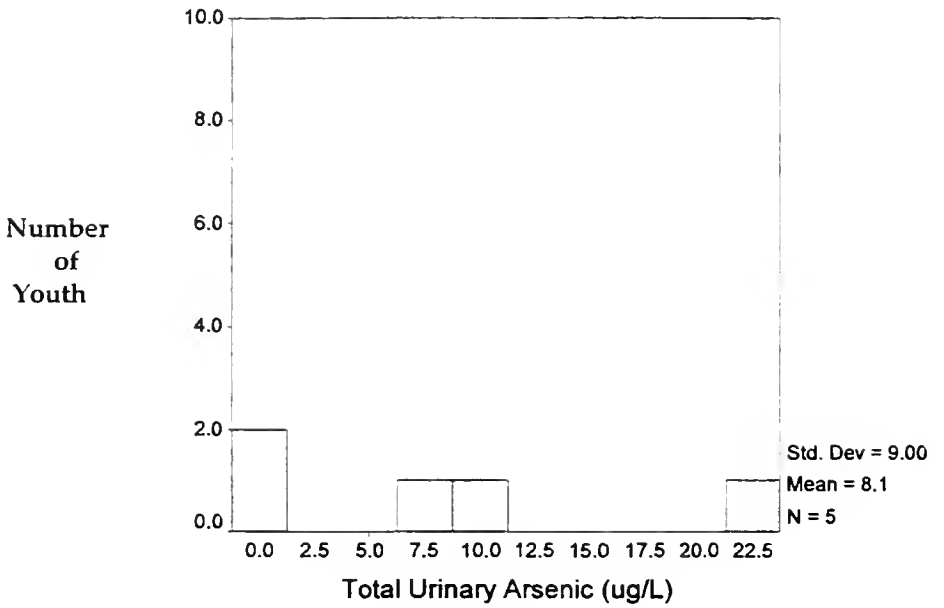
* assuming non-detectable As as 0 μg/L

Figure 5a: Frequency Distribution for Total Urinary Arsenic of Children (≤ 12 years) in Havelock*



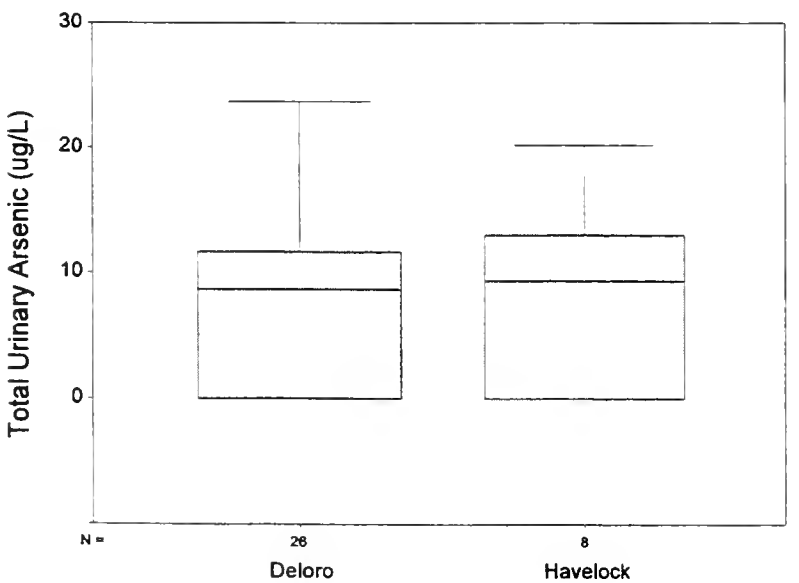
* assuming non-detectable As as 0 μg/L

Figure 5b: Frequency Distribution for Total Urinary Arsenic of Youth (13 - 19 inclusive) in Havelock*



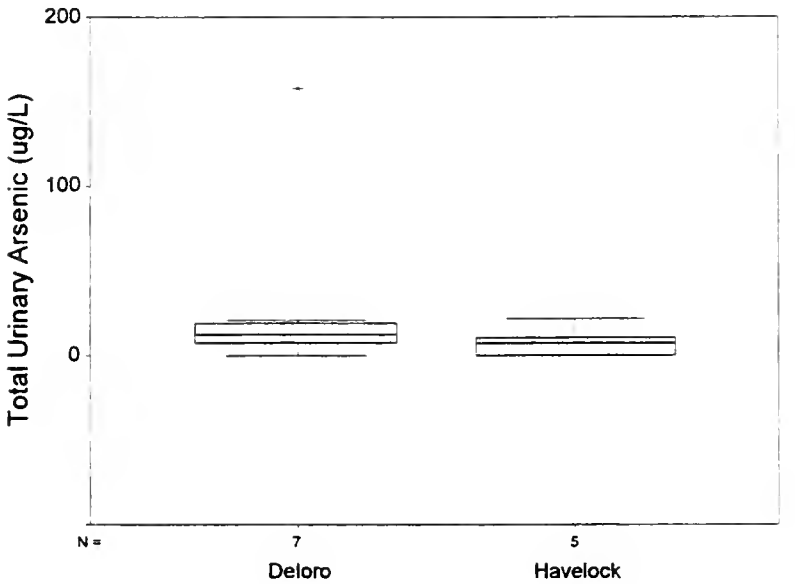
* assuming non-detectable As as 0 μg/L

Figure 6a: Box Plot of Total Urinary Arsenic of Children (≤ 12 years) in Deloro and Havelock*



* assuming non-detectable As as 0 μg/L

Figure 6b: Box Plot for Total Urinary Arsenic of Youth (13 - 19 inclusive) in Deloro and Havelock*



* assuming non-detectable As as 0 μg/L

4.2.2 Speciated (Inorganic) Arsenic

Since any adverse health effects of As exposure is primarily due to the exposure to speciated (inorganic) arsenic, analysis of speciated As was also carried out for all residents. Only 16 residents from Deloro and 8 residents from Havelock had detectable levels of speciated As.

Tables 2a and 2b give the mean speciated As levels for the residents of Deloro and Havelock. Again, the difference in mean levels is not statistically significant ($P>.05$). While there is no accepted threshold levels for speciated arsenic, data for two residents in Havelock and four in Deloro were examined separately since they had levels above 15 μg/L. Questionnaire data for these residents were examined separately to see if there was any association with potential exposure to arsenic from their environment or with other confounding factors (further details are given below).

Table 2a: Speciated As (inorganic) for residents of Deloro and Havelock

Urinary Arsenic (inorganic)(μg/L)

	Assuming Non-detectable As as 3 μg/L		Assuming Non-detectable As as 0 μg/L	
	Deloro	Havelock	Deloro	Havelock
Mean	4.36	4.57	1.76	2.02
Range	3 - 23.44	3 - 19.9	0 - 23.44	0 - 19.9
Std. Dev.	4	3.98	4.92	5.02
n	121	53	121	53

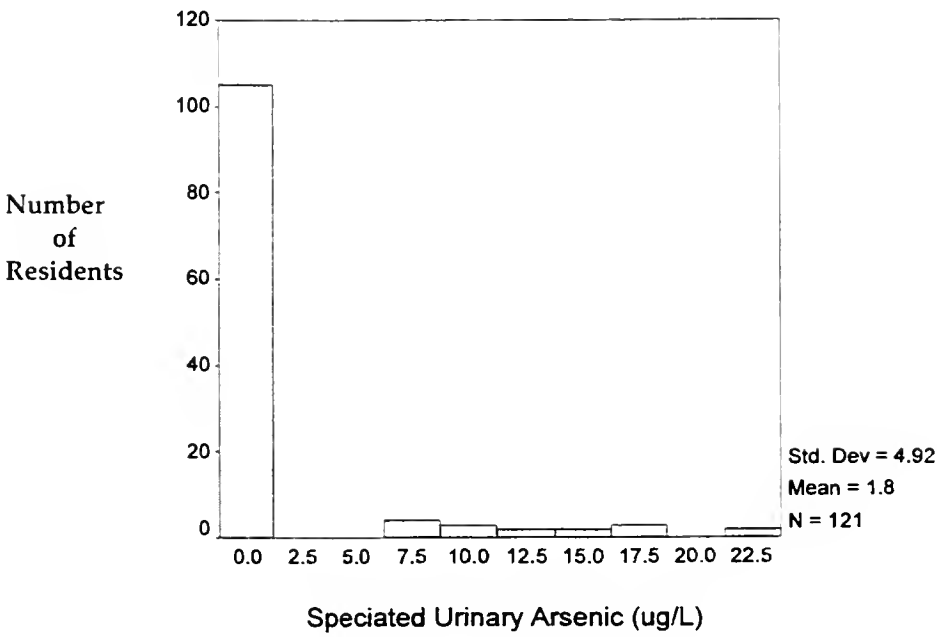
Table 2b: Speciated As (inorganic) for residents with detectable levels of As only

Urinary Arsenic (inorganic) (μg/L)

	Deloro	Havelock
Mean	13.31	13.38
Range	6.28 - 23.44	9.02 - 19.9
Std. Dev.	5.42	3.65
n	16	8

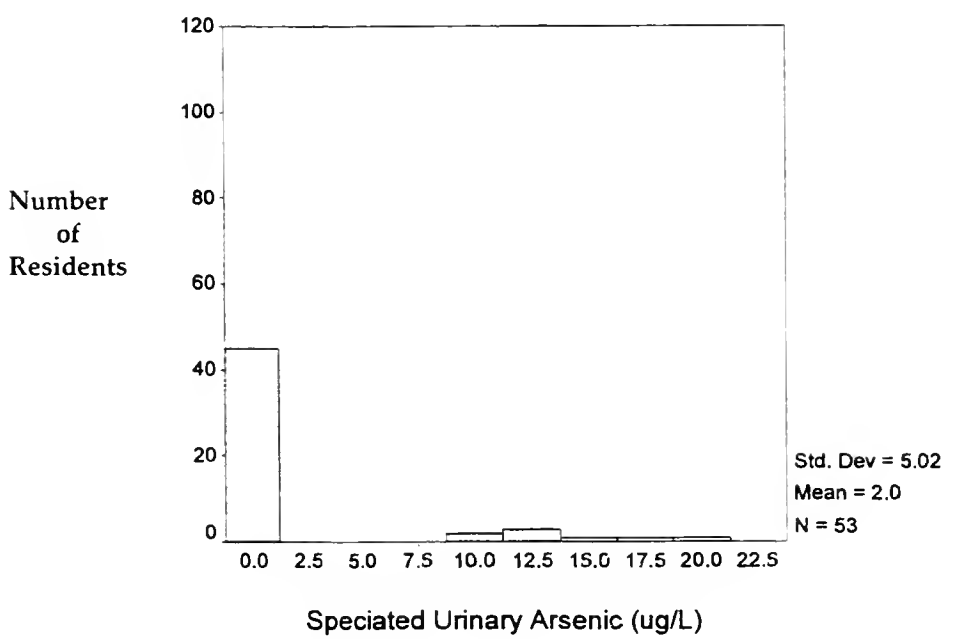
The frequency distributions (histograms), **Figures 7 and 8**, and the box plots **(Figure 9)** for speciated (inorganic) urinary arsenic in Deloro and Havelock are presented below. The close similarities between the distributions are evident, and no statistical difference in the means was found between Deloro and Havelock for all comparisons (i.e., assuming non-detectable As as 3 μg/L or 0 μg/L).

Figure 7: Frequency Distribution for Speciated (inorganic) Urinary Arsenic of Residents in Deloro*



* assuming non-detectable As as 0 μg/L

Figure 8: Frequency Distribution for Speciated (inorganic) Urinary Arsenic of Residents in Havelock*



* assuming non-detectable As as 0 μg/L

Figure 9a: Box Plots of Speciated (inorganic) Urinary Arsenic of Residents in Deloro and Havelock (assuming non-detectable As as 0 μg/L)

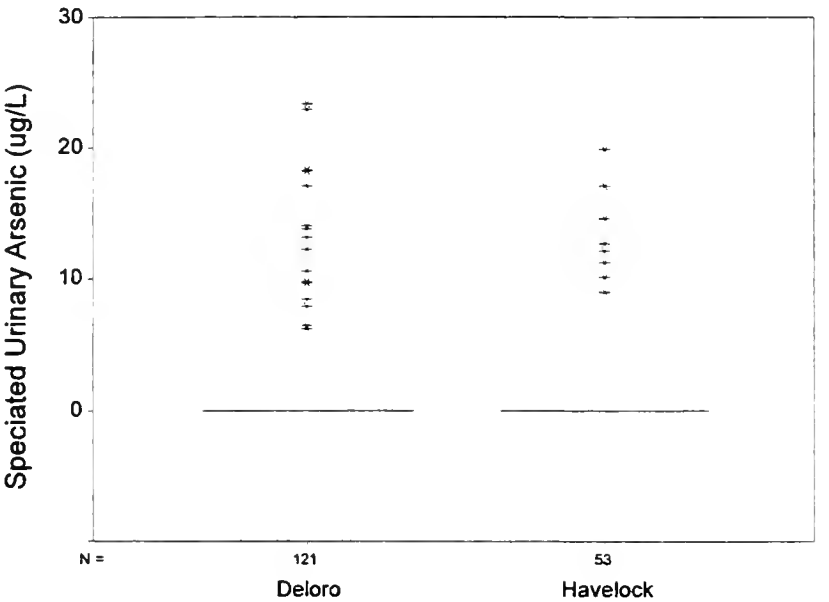
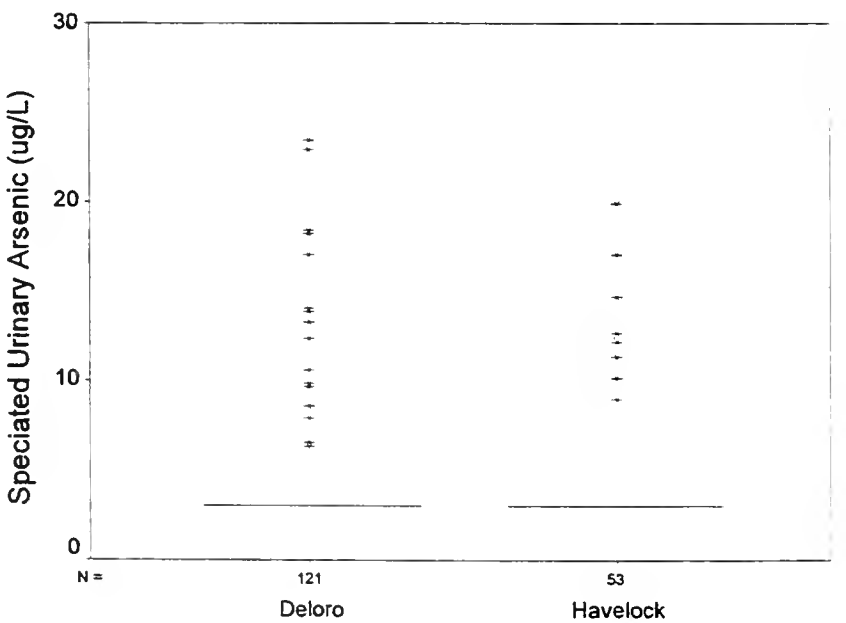


Figure 9b: Box Plots of Speciated (inorganic) Urinary Arsenic of Residents in Deloro and Havelock (assuming non-detectable As as 3 μg/L)



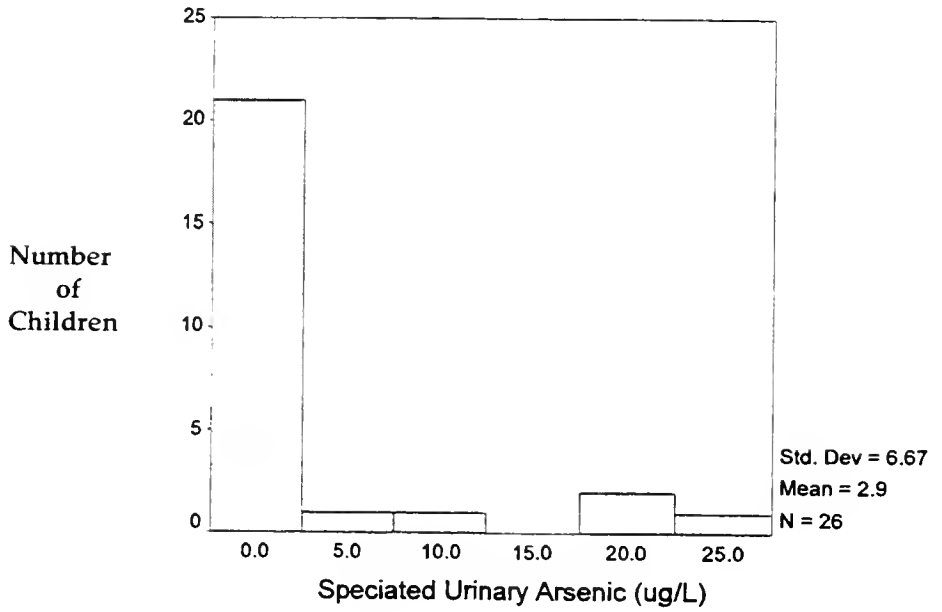
Although the sample sizes are quite small, statistical comparisons were carried out on the speciated (inorganic) urinary arsenic data for the children (12 years and under) and youth (13 to 19 years inclusive) in Deloro and Havelock. **Table 2c** summarizes the speciated (inorganic) urinary arsenic for the children/youth Deloro-Havelock comparisons, while **Figures 10, 11, and 12** show the related frequency distributions (histograms) and box plots. As can be seen by these Figures, the children/youth distributions for Deloro-Havelock are similar to what was observed for the entire study samples. Statistical tests (e.g., t-test of mean) were also conducted for comparing the Deloro-Havelock children/youth (19 and below) data. No statistically significant differences ($P>0.05$) were found.

Table 2c: Speciated Urinary Arsenic ($\mu g/L$) of Children/Youth of Deloro and Havelock*

	Assuming Non-detectable As as 3 $\mu g/L$				Assuming Non-detectable As as 0 $\mu g/L$			
	Deloro		Havelock		Deloro		Havelock	
	Children	Youth	Children	Youth	Children	Youth	Children	Youth
Mean	5.34	5.01	7.01	6.38	2.92	2.44	5.51	3.98
Range	3 - 22.93	3 - 17.10	3 - 12.72	3 - 19.90	0 - 22.93	0 - 17.10	0 - 12.72	0 - 19.90
Std. Dev.	5.59	5.33	4.44	7.56	6.67	6.46	6	8.9
n	26	7	8	5	26	7	8	5

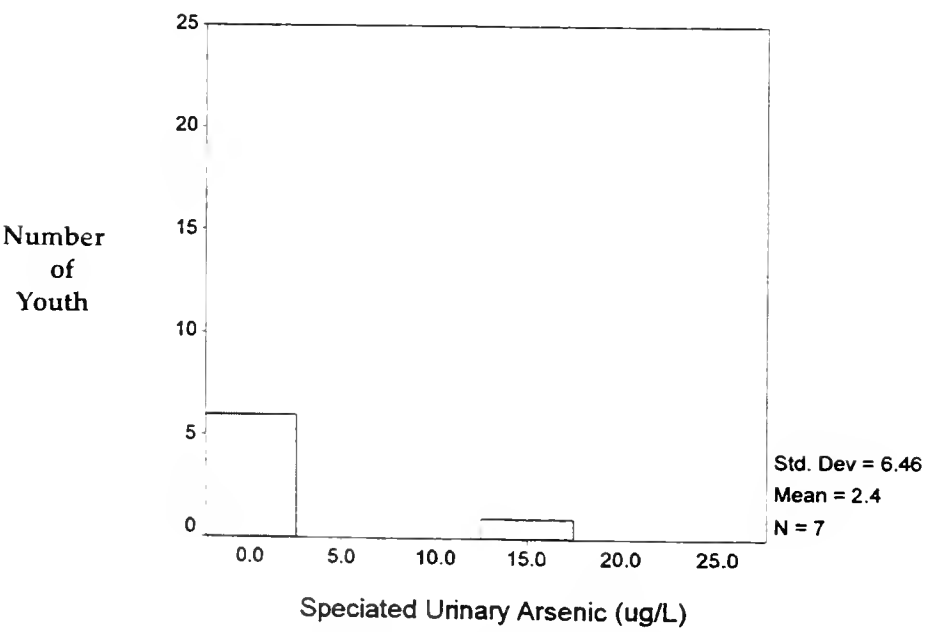
* children defined as ≤ 12 years of age.
youth defined as 13 - 19 years of age inclusive.

Figure 10a: Frequency Distribution for Speciated (inorganic) Urinary Arsenic of Children (≤ 12 years) in Deloro*



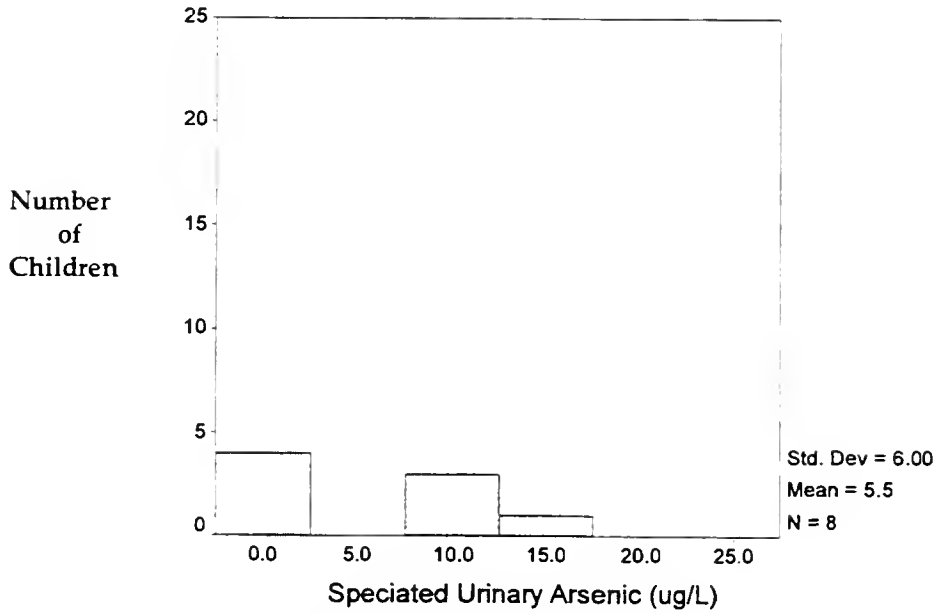
* assuming non-detectable As as 0 μg/L

Figure 10b: Frequency Distribution for Speciated (inorganic) Urinary Arsenic of Youth (13 - 19 inclusive) in Deloro*



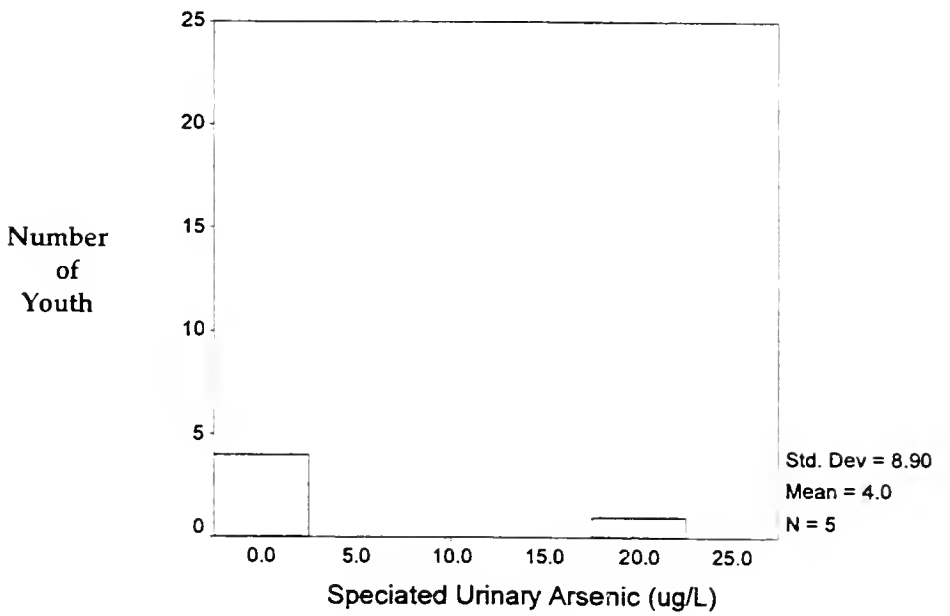
* assuming non-detectable As as 0 μg/L

Figure 11a: Frequency Distribution for Speciated (inorganic) Urinary Arsenic of Children (≤ 12 years) in Havelock*



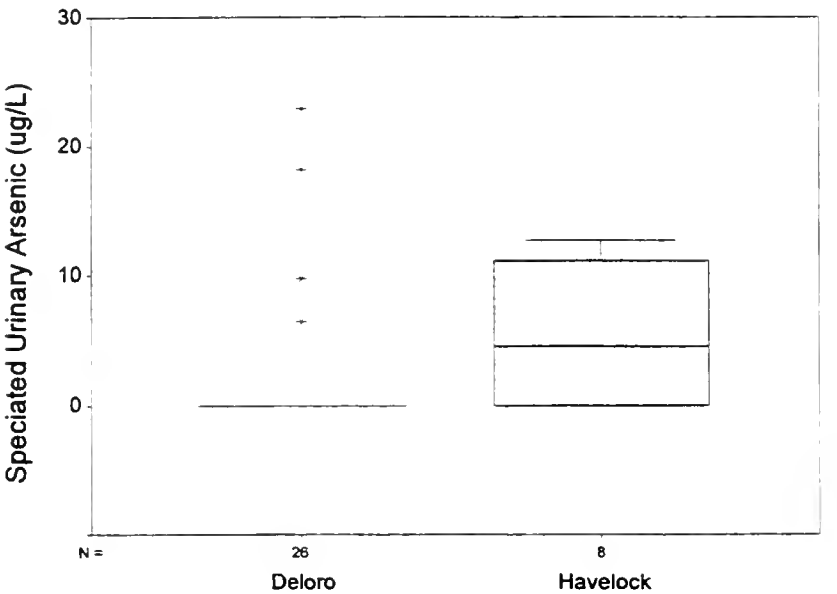
* assuming non-detectable As as 0 μg/L

Figure 11b: Frequency Distribution for Speciated (inorganic) Urinary Arsenic of Youth (13 - 19 inclusive) in Havelock*



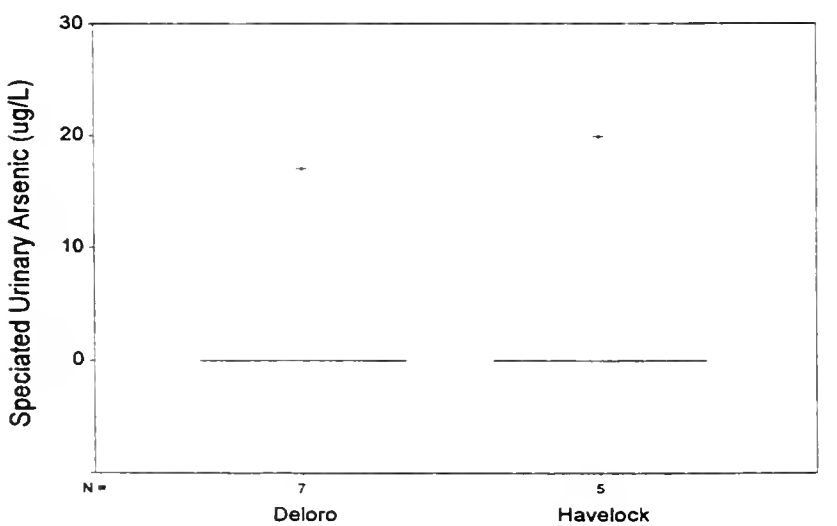
* assuming non-detectable As as 0 μg/L

Figure 12a: Box Plot of Speciated (inorganic) Urinary Arsenic of Children (≤ 12 years) in Deloro and Havelock*



* assuming non-detectable As as 0 μg/L

Figure 12b: Box Plot of Speciated (inorganic) Urinary Arsenic of Youth (13 - 19 inclusive) in Deloro and Havelock*



* assuming non-detectable As as 0 μg/L

4.3 Health Profile of the Communities: Descriptive Analysis

In order to assess the population characteristics for the two communities and to identify any potential confounding factors for the analysis of association of As levels with reported health effects, information on socio-demographic characteristics, diet, house and other living environment as well as reported health outcomes and use of medications was collected. The rates of responses in each category for the two communities were statistically compared using the chi-square test. The following sections deal with the analysis of these data.

4.3.1 Socio-demographic Characteristics

Tables 3, 4, 5, 6 and 7 give the distribution of subjects for gender, age, education, occupation and income for the two communities.

In spite of matching for broad age groups, the Deloro population is slightly younger than the sample from Havelock. The matching was done based on prior information on the age distribution of residents of Deloro from the latest census data (1996) and these were slightly different from the actual age distribution that we obtained in the study. This minor difference in age distribution is not expected to have any major impact on the conclusions reached in the study.

Proportionately more residents from Havelock refused to answer the question about income (13% Havelock; 6% Deloro). For those who responded to the question, median annual income of Havelock residents was over $40,000 while the median annual income for Deloro residents was less than $30,000. Questions were asked about any additional occupations that these residents might have and (while smaller in number) they showed similar patterns and were comparable for the two communities.

Table 3: Gender Distribution of Respondents

	Deloro	Havelock
	No. (%)	No. (%)
Male	67 (48%)	26 (48%)
Female	73 (52%)	28 (52%)
Total	140 (100%)	54 (100%)

Table 4: Age Distribution of Respondents

	Deloro No. (%)	Havelock No. (%)
0 - 15 years	37 (27%)	13 (24%)
16 - 39	36 (26%)	7 (13%)
40 and over	64 (46%)	33 (61%)
Refused and Missing	2 (1%)	1 (2%)
Total	140 (100%)	54 (100%)
Mean Age (standard deviation)	36.09 (22.32)	42.13 (23.36)

Table 5: Education of Respondents

	Deloro No. (%)	Havelock No. (%)
Primary (< Grade 6)	16 (11%)	8 (15%)
Secondary (Grade 6 - 12)	73 (52%)	23 (43%)
Post Secondary	29 (21%)	17 (31%)
Refused and Missing	22 (16%)	6 (11%)
Total	140 (100%)	54 (100%)

Table 6: Primary Occupation of Respondents

	Deloro No. (%)	Havelock No. (%)
Retail and Service	12 (9%)	2 (4%)
Homemaker	16 (12%)	3 (6%)
Student	39 (29%)	15 (28%)
Retired	17 (13%)	16 (29%)
Administration	10 (7%)	7 (13%)
Other	41 (30%)	11 (20%)
Total	135* (100%)	54 (100%)

* does not include 5 Deloro residents < 4 years of age

Table 7: Household Income (Before Taxes) of Respondents

	Deloro No. (%)	Havelock No. (%)
Under $10,000	7 (5%)	0 (0%)
$10,000 - $20,000	29 (21%)	4 (7%)
$20,000 - $30,000	29 (21%)	9 (17%)
$30,000 - $40,000	33 (23%)	8 (15%)
$40,000 - $50,000	10 (7%)	18 (33%)
Over $50,000	24 (17%)	8 (15%)
Refused and Missing	8 (6%)	7 (13%)
Total	140 (100%)	54 (100%)

The differences in the distribution of these characteristics between the two communities were not statistically significant ($P>0.05$).

4.3.2 Health and Lifestyle Indicators

Five specific health and lifestyle indicators were examined across both communities: smoking, consumption of fish, reported health problems, medication and diet supplementation use, and height and weight.

Smoking. **Table** 8 gives the smoking status of the residents 16 years of age and over in the two communities. While there were some children below 16 years of age who reported smoking (3 children in Deloro and none in Havelock), it was considered more appropriate to compare the smoking habits of the adults in this table. There were more smokers in Deloro, but more ex-smokers in Havelock. The proportions of non-smokers were similar.

Table 8: Smoking Status Among Respondents Over 16 Years of Age

	Deloro No. (%)	Havelock No. (%)
Current Smoker	51 (50%)	7 (17%)
Ex-smoker	18 (17%)	20 (49%)
Non-smoker	32 (31%)	12 (29%)
Refused and Missing	2 (2%)	2 (5%)
Total	103 (100%)	41 (100%)

Consumption of fish. **Tables 9, 10 and 11** give information about the consumption of fish by the residents.

Table 9 gives the number responding positively to the question of whether they eat a particular type of fish, and the proportion who answered that they eat the type of fish more often than once per month. All of the respondents in Havelock reported consuming shellfish and whole fish less frequently than once a month, while 25% and 38% of Deloro residents who reported consuming shellfish and whole fish respectively, consumed it more frequently than once per month.

From **Table 10**, in the past seven days 37% of the sampled residents of Havelock consumed fish, while 44% of the Deloro residents reported eating fish meals. **Table 11** indicates that 8% of Deloro residents (or, 11 residents) reported having eaten fish caught from the Moira river.

Table 9: Responses to "How often has the family eaten the following types of fish/fish products": Percentage of Respondents with Frequency "more often than once a month"

	Deloro		Havelock	
	No. Responding	% yes	No. Responding	% yes
Fish Fillets/Steaks	73	55	34	29
Frozen Fish Dinner	87	36	36	22
Shellfish	40	25	16	0
Whole fish	16	38	18	0
Canned fish	118	64	47	68

Table 10: Responses to "have you eaten fish meals in the past seven days"

Deloro		Havelock	
No. Responding	% yes	No. Responding	% yes
140	44	44	37

Table 11: Responses to "do you eat fish from Moira Lake"

Deloro		Havelock	
No. Responding	% yes	No. Responding	% yes
137	8	44	0

Reported health problems. The majority of reported health problems were high cholesterol (12 respondents in Deloro; 7 in Havelock), high blood pressure (6, Deloro; 3, Havelock), gastrointestinal problems (7, Deloro; 4, Havelock), and common conditions such as allergies to mold, and asthma. Two persons from Deloro and 2 from Havelock reported skin cancer. Three persons from Deloro also reported skin rashes or blemishes among the health problems. Other reported health problems (mostly one or two persons reporting, either from Deloro or Havelock) included: musculoskeletal problems, glaucoma, and cardiovascular problems. Overall, 27 persons from Deloro and 20 from Havelock reported more than one health problem. Thirteen from Deloro and 12 from Havelock reported 3 or more health problems. The differences in reported rates were not statistically significant ($P>0.05$).

Medication and diet supplementation use. In total, 54 persons from Deloro and 28 from Havelock reported current use of medications. The medications used related to the reported health problems. No differences in the pattern of medications used between the two communities could be detected. Overall, 44 respondents from Deloro and 27 from Havelock reported regular usage of diet supplements, primarily vitamin and calcium supplementation. Only 9 persons from Deloro and 5 from Havelock reported to be on special diets recommended by their physicians. These special diets were to control cholesterol or sugar levels. The differences in reported rates were not statistically significant ($P>0.05$).

Height and Weight. The height and weight distribution of respondents were similar for the two communities ($P>0.05$). Deloro residents reported an average of 149 pounds (std.dev. 52.3) while the Havelock residents reported an average of 154 pounds (std.dev. 49.1). The average height of respondents from Deloro and Havelock were 1.61 meters (std.dev. 0.18) and 1.63 meters (std.dev. 0.18) respectively. There was no significant difference in the proportion of respondents who could be considered obese ($P>0.05$). The same proportion (16%) of Deloro and Havelock respondents (22 for Deloro and 7 for Havelock) reported a noticeable change in their weight over the last six months.

4.4 Environmental Factors

Eight environmental factors were studied across the two communities: house characteristics, presence and use of vegetable garden, pesticide use, use of well water, swimming in Moira Lake, pets in the house, occupational exposure and child's environment.

4.4.1 House Characteristics

The following house characteristics were compared using the Deloro and Havelock data.

Length and type of Residence. Most of the respondents were long term residents of their respective communities. Thirty-six (36) of the Deloro residents (mostly children) lived less than 3 years in Deloro. There were no one with less than 3 years of residence in Havelock. All of the residents lived in a house (except for two residents of Deloro who reported as living in an apartment in a building with less than 5 storeys, presumably as boarders in the house). The majority of the houses were built more than 53 years ago (75 % in Deloro and 80% in Havelock).

Heating was done by gas, electricity or wood alone or in combination. There was no difference in the percentages for various type of heating for the two communities.

40% of the Deloro residents and 50% of Havelock residents had air conditioning in their homes. Only 1% of the homes (both in Deloro and Havelock) had air cleaners installed.

None of the above differences were statistically significant ($P>0.05$).

Renovations to the residences. 30% of the households in Deloro and 53% of households in Havelock reported having some renovations made in the past year. There was no noticeable differences in the type of renovations carried out in each community.

4.4.2 Presence and Use of Vegetable Garden

All the residences had a 'yard' and the majority of them had vegetable gardens (45% in Deloro and 80% in Havelock). The residents regularly consumed vegetables from their vegetable gardens in the summer.

4.4.3 Pesticide Use

20% of the homes used pesticides in both Deloro and Havelock.

4.4.4 Use of Well Water

Most of the residences in Havelock did not have a ground water well, while 30% of the residents in Deloro had wells. The Deloro residents used the water from the wells for drinking. In our (component) study, measurement of arsenic in the well water was not done.

4.4.5 Swimming in Moira Lake

10% (14/137) of the respondents from Deloro reported swimming or wading in the Moira river. As expected, none of the Havelock residents reported this event.

4.4.6 Pets in the House

90% of the households in Deloro and 55% of household in Havelock had pets in their homes. Most of these pets (more than 90%) were allowed to go outside. In Deloro, 50% of the pets spend most of the day outside (more than 10 hours per day) while in Havelock, 75% of the pets go out rarely (less than one hour per day) and 25% spend between one and 10 hours per day outside.

4.4.7 Occupational Exposure

Two occupational exposures were studied across the two communities: work exposure to chemicals, and work in the Deloro mine.

Work exposure to chemicals. Of the 114 respondents from Deloro who answered the question about work exposure to chemicals (some of the children under 18 had responses to this question, presumably their exposure at school), 77% (88/114) reported no chemical exposure at work. In Havelock, 22 of 32 respondents (69%) reported no chemical exposure at work. The difference was not statistically significant ($P>0.05$). Of those reporting chemical exposure at work, none of the exposures were related to arsenic. There was no noticeable difference in the types of chemicals between the two communities.

Work in Deloro mine. 4% (5/115) of the respondents from Deloro and 10% (4/41) of the respondents from Havelock reported having worked in the Deloro mine.

4.4.8 Child's Environment

Only two children from Deloro reported not washing their hands before eating. Four children reported not washing their hands or face before going to sleep. In Havelock, all 13 children reported washing their hands before eating and washing hands and face before going to sleep.

Most of the children reported being away from home less than 9 hours. The majority (60% in Deloro and 62% in Havelock) reported about 8 hours spent outside home. Most of this time was in school.

The children's favourite play area was either the backyard or the park (55% and 54% for Deloro and Havelock, respectively). 35% of this area in Deloro and 18% in Havelock, was bare, unsodded ground. More than 65% of the children's favourite indoor play area was the family room, bedroom, TV room or play room.

None of the differences between the two communities was statistically significant ($P>0.05$).

4.5 Relationship of Arsenic Levels with Health and Environment Variables

As noted in the descriptive part of the results, the two communities were quite similar in most of the potential risk factors assessed.

The arsenic levels were quite similar for the two communities, especially with respect to the speciated (inorganic) arsenic levels which is the important component as far as health effects are concerned.

A linear regression analysis, with urinary As as dependent variable and the various socio-demographic, health and lifestyle, environmental and occupational variables as

independent variables, was carried out. For both total As and speciated As, the non-detectable levels were assigned as 0 for this analysis, as replacing zero with 3 (half the detection limit) will not change the analysis appreciably. In all the analyses, the independent variables were recoded to be ordinal so that they could be considered continuous for analysis purposes. If the variables were left as nominal it would have necessitated the use of 'dummy variables' in the regression, with a resulting loss of many degrees of freedom (leading to less statistical power for the interpretation of results). That is, with a sample size between 50 and 130 in most cases, this would have made the regression analysis not very useful (low statistical power).

The analyses are grouped under four separate headings, reflecting the different models and data analyses carried out: i) relationship of urinary arsenic with socio-demographic variables; ii) relationship of urinary arsenic with health and lifestyle indicators; iii) relationship of urinary arsenic with house characteristics; and, iv) relationship of urinary arsenic with occupational exposure.

4.5.1 Relationship of Urinary Arsenic with Socio-demographic Variables

Total Urinary Arsenic. Age, income and education were used as independent (predictor) variables. The linear regression with total arsenic as dependent variable did not identify any significant relationships. The model including all three variables in the equation did not explain any of the total variation.

Table 12a gives the ANOVA results and **Table 12b** gives the regression coefficients for this regression analysis.

Table 12a: ANOVA Results - Total Urinary Arsenic and Socio-demographic Variables

Model		Sum of Squares	df	Mean Square	F	Sig.
Socio-	Regression	1467.510	3	489.170	1.000	.396
	Residual	50853.840	104	488.979		
	Total	52321.350	107			

R^2=.000

Predictors: (Constant), Q4 - what is participant's age, Q50 - household income before tax for 1997, Q13 - what was highest grade/diploma finished in school.
Dependent Variable: Total arsenic in micrograms of arsenic per litre of urine.

Table 12b: Regression Coefficients - Total Urinary Arsenic and Socio-demographic Variables

Model		B	Std. Error	Beta	t	Sig.
Socio-	(Constant)	3.012	7.435		.405	.686
	Q50-household income before tax for 1997	2.382	1.376	.177	1.732	.086
	Q13-what was highest grade or diploma finished in school	-.346	.636	-.064	-.544	.588
	Q4-what is participants age	5.966E-02	.119	.059	.501	0.617

Dependent Variable: Total arsenic in micrograms of arsenic per litre of urine.

Speciated (Inorganic) Urinary Arsenic. Similar results hold true for speciated (inorganic) urinary arsenic as dependent variable. The regression model explained only 4% of the total variation in speciated urinary arsenic. **Table 13** gives the results.

Table 13a: ANOVA Results - Speciated Urinary Arsenic and Socio-demographic Variables

Model		Sum of Squares	df	Mean Square	F	Sig.
Socio-	Regression	195	3	65	2.542	0.06
	Residual	2659.847	104	25.575		
	Total	2854.847	107			

R^2=0.041

Predictors: (Constant), Q7 - has any member worked at Deloro mine, Q6 - work/exposed to chemicals.
Dependent Variable: Speciated (inorganic/non-dietary) arsenic measured in micrograms of arsenic per litre of urine.

Table 13b: Regression Coefficients - Speciated Urinary Arsenic and Socio-demographic Variables

Model		B	Std. Error	Beta	t	Sig.
Socio-	(Constant)	6.390	1.700		3.758	.000
	Q50-household income before tax for 1997	-.455	.315	-.145	-1.445	.151
	Q13-what was highest grade or diploma finished in school	-.135	.145	-.107	-.926	.357
	Q4-what is participants age	-3.481E-02	.027	-.147	-1.278	.204

Dependent Variable: Speciated (inorganic/non-dietary) arsenic measured in micrograms of arsenic per litre of urine.

4.5.2 Relationship of Urinary Arsenic with Health and Lifestyle Indicators

Total Urinary Arsenic. Regression analysis for total urinary arsenic was done, using smoking, consumption of fish, special diet, height, weight, and use of vitamins and supplements as independent variable. Only consumption of fish fillet, frozen fish and canned fish were included in the analysis, since the other types of fish had low response rates and in the multiple linear regression, the effective sample sizes would become too low for any meaningful statistical analyses. **Table 14** gives the ANOVA and regression coefficients results for the regression model. Only 22.5% of the total variation was explained by this model. None of the variables had statistically significant regression coefficient for the total arsenic ($P>0.05$).

Table 14a: ANOVA Results - Total Urinary Arsenic and Health and Lifestyle Indicators

Model		Sum of Squares	df	Mean Square	F	Sig.
Health...	Regression	17343.785	7	2477.684	2.409	.047
	Residual	27767.836	27	1028.438		
	Total	45111.621	34			

$R^2=.225$

Predictors: (Constant), Q35b - what is your present weight, Q33 - during the last three months has participants been taking any vitamins, minerals, or other dietary supplements, Q25d - how often in the past 12 months has the family eaten canned fish, Q25b - how often in the past 12 months has the family eaten frozen fish sticks/dinners, Q11a - does he/she smoke, Q25a - how often in past 12 months has family eaten fish fillets/steaks, Q35a - what is your present height (in metres).
Dependent Variable: Total arsenic in micrograms of arsenic per litre of urine.

Table 14b: Regression Coefficients - Total Urinary Arsenic and Health and Lifestyle Indicators

Model		B	Std. Error	Beta	t	Sig.
Health...	(Constant)	-99.986	68.650		-1.456	.157
	Q11a-does he/she smoke	11.337	7.053	.280	1.607	.120
	Q25a-how often in past 12 months has family eaten fish fillets/steaks	-4.518	2.524	-.376	-1.790	.085
	Q25b-how often in the past 12 months has the family eaten frozen fish sticks/dinners	2.841	2.259	.250	1.258	.219
	Q25d-how often in the past 12 months has the family eaten canned fish	2.819	1.450	.312	1.944	.062
	Q33-during the last three months has participants been taking any vitamins, minerals, or other dietary supplements	-4.854	13.273	-.063	-.366	.717
	Q35a-what is your present height (in metres)	85.655	44.748	.409	1.914	.066
	Q35b-what is your present weight	-.258	.154	-.340	-1.676	.105

Dependent Variable: Total arsenic in micrograms of arsenic per litre of urine.

Speciated (Inorganic) Urinary Arsenic. Similar regression analysis was done for speciated arsenic, using smoking, consumption of fish, special diet, height, weight, and use of vitamins and supplements as independent variable. Only consumption of fish fillet, frozen fish and canned fish were included in the analysis, since the other types of fish had low response rates and in the multiple linear regression, the effective sample sizes would become too low for any meaningful statistical analyses. The regression model explained only 10% of the total variation in speciated urinary arsenic, which was used as the dependent variable. **Table 15** gives the results. None of the variables had statistically significant regression coefficient for the speciated arsenic ($P>0.05$). Use of vitamins and supplements had a statistically significant coefficient ($P<0.05$) for speciated arsenic, with people using these supplements having a lower speciated arsenic level by the model. However, the overall regression was not statistically significant ($P>0.2$).

Table 15a: ANOVA Results - Speciated Urinary Arsenic and Health and Lifestyle Indicators

Model		Sum of Squares	df	Mean Square	F	Sig.
Health...	Regression	61.401	7	8.772	1.532	.199
	Residual	154.583	27	5.725		
	Total	215.985	34			

$R^2=.099$

Predictors: (Constant), Q35b - what is your present weight, Q33 - during the last three months has participants been taking any vitamins, minerals, or other dietary supplements, Q25d - how often in the past 12 months has the family eaten canned fish, Q25b - how often in the past 12 months has the family eaten frozen fish sticks/dinners, Q11a - does he/she smoke, Q25a - how often in past 12 months has family eaten fish fillets/steaks, Q35a - what is your present height (in metres).
Dependent Variable: Speciated (inorganic/non-dietary) arsenic measured in micrograms of arsenic per litre of urine.

Table 15b: Regression Coefficients - Speciated Urinary Arsenic and Health and Lifestyle Indicators

Model		B	Std. Error	Beta	t	Sig.
Health...	(Constant)	3.214	5.122		.627	.536
	Q11a-does he/she smoke	.348	.526	.124	.662	.514
	Q25a-how often in past 12 months has family eaten fish fillets/steaks	-.134	.188	-.162	-.713	.482
	Q25b-how often in the past 12 months has the family eaten frozen fish sticks/dinners	.176	.169	.224	1.044	.306
	Q25d-how often in the past 12 months has the family eaten canned fish	-4.000E-02	.108	-.064	-.370	.715
	Q33-during the last three months has participants been taking any vitamins, minerals, or other dietary supplements	-2.210	.990	-.413	-2.232	.034
	Q35a-what is your present height (in metres)	1.342	3.339	.093	.402	.691
	Q35b-what is your present weight	-1.076E-02	.011	-.205	-.937	.357

Dependent Variable: Speciated non-dietary arsenic measured in micrograms of arsenic per litre of urine.

4.5.3 Relationship of Urinary Arsenic with House Characteristics

Total Urinary Arsenic. Regression analysis for total urinary arsenic as dependent variable was performed, using length and type of residence, any renovations done to the house, presence of vegetable garden, use of pesticide, use of well water and swimming in the Moira river as independent (predictor) variables. **Table 16** gives the ANOVA and regression coefficients results for the regression of total urinary arsenic. Only 0.2% of variation was explained by the model and the overall regression was not statistically significant ($P>0.05$). None of the regression coefficients were statistically significant ($P>0.05$).

Table 16a: ANOVA Results - Total Urinary Arsenic and House Characteristics

Model		Sum of Squares	df	Mean Square	F	Sig.
House...	Regression	3227.955	7	461.136	1.039	.408
	Residual	49704.348	112	443.789		
	Total	52932.304	119			

$R^2=.002$

Predictors: (Constant), Q47a - do you have a groundwater well on your property, Q36 - how long have you lived in Deloro (in yrs), Q45a - do you have a garden, Q12a - do you swim/wade in Moira River/Lake, Q46a - have you applied any pesticides to your garden and/or lawn, Q41 - have any of the following been done to the inside or outside of your home in the past year/added or taken away walls, floors, windows, or rooms, Q40 - when was the house or apartment building originally built.
Dependent Variable: Total arsenic in micrograms of arsenic per litre of urine.

Table 16b: Regression Coefficients - Total Urinary Arsenic and House Characteristics

Model		B	Std. Error	Beta	t	Sig.
House...	(Constant)	19.739	20.019		.986	.326
	Q41-have any of the following been done to the inside or outside of your home in the past year/added or taken away walls, floors, windows, or rooms	.673	4.706	.015	.143	.887
	Q12a-do you swim/wade in Moira River/Lake	-.722	6.733	-.010	-.107	.915
	Q36-how long have you lived in Deloro (in yrs)	-5.190E-02	.140	-.036	-.370	.712
	Q40-when was the house or apartment building originally built	-3.643	1.841	-.222	-1.979	.050
	Q45a-do you have a garden	6.350	4.426	.150	1.435	.154
	Q46a-have you applied any pesticides to your garden and/or lawn	2.087	5.184	.040	.403	.688
	Q47a-do you have a groundwater well on your property	-9.009	5.110	-.202	-1.763	.081

Dependent Variable: Total arsenic in micrograms of arsenic per litre of urine.

Speciated (Inorganic) Urinary Arsenic. Similar regression analysis was done for speciated arsenic, using length and type of residence, any renovations done to the house, presence of vegetable garden, use of pesticide, use of well water and swimming in the Moira river as independent variables. Table 17 gives the ANOVA and regression coefficients results for speciated urinary arsenic as dependent variable. Only 4.4% of the variation in speciated As is explained by this model and the regression is not statistically significant ($P>0.05$). None of the regression coefficients are statistically significant ($P>0.05$).

Table 17a: ANOVA Results - Speciated Urinary Arsenic and House Characteristics

Model		Sum of Squares	df	Mean Square	F	Sig.
House...	Regression	284.250	7	40.607	1.784	.097
	Residual	2549.782	112	22.766		
	Total	2834.031	119			

$R^2 = .044$

Predictors: (Constant), Q47a - do you have a groundwater well on your property, Q36 - how long have you lived in Deloro (in yrs), Q45a - do you have a garden, Q12a - do you swim/wade in Moira River/Lake, Q46a - have you applied any pesticides to your garden and/or lawn, Q41 - have any of the following been done to the inside or outside of your home in the past year/added or taken away walls, floors, windows, or rooms, Q40 - when was the house or apartment building originally built.
Dependent Variable: Speciated non-dietary arsenic measured in micrograms of arsenic per litre.

Table 17b: Regression Coefficients - Speciated Urinary Arsenic and House Characteristics

Model		B	Std. Error	Beta	t	Sig.
House...	(Constant)	1.784	4.534		.393	.695
	Q41-have any of the following been done to the inside or outside of your home in the past year/added or taken away walls, floors, windows, or rooms	.227	1.066	.022	.213	.832
	Q12a-do you swim/wade in Moira River/Lake	-.841	1.525	-.052	-.551	.583
	Q36-how long have you lived in Deloro (in yrs)	-2.937E-02	.032	-0.09	-0.924	.357
	Q40-when was the house or apartment building originally built	1.987E-02	.417	.005	.048	.962
	Q45a-do you have a garden	-2.529	1.453	-0.259	-1.74	0.061
	Q46a-have you applied any pesticides to your garden and/or lawn	2.185	1.174	.183	1.861	.065
	Q47a-do you have a groundwater well on your property	.901	1.157	.087	.778	.438

Dependent Variable: Speciated non-dietary arsenic measured in micrograms of arsenic per litre of urine.

4.5.4 Relationship of Urinary Arsenic with Occupational Exposure

Total Urinary and Speciated Arsenic. Exposure to chemicals at work (including school for some high school students), and whether they worked in the Deloro mine were used as independent variables in this regression analysis. As above, total urinary arsenic and speciated urinary arsenic were used as the dependent variable in separate regression models. Again, there was no statistically significant associations as seen from Tables 18 and 19 below. The regression models could not explain any of the variations observed in the arsenic levels (R^2=.000 in both models).

Table 18a: ANOVA Results - Total Urinary Arsenic and Occupational Exposure

Model		Sum of Squares	df	Mean Square	F	Sig.
Occup Exp	Regression	14.199	2	7.099	.023	.977
	Residual	29986.564	99	302.895		
	Total	30000.763	101			

R^2=.000

Predictors: (Constant), Q7 - has any member worked at Deloro mine, Q6 - work/exposed to chemicals.

Dependent Variable: Total arsenic in micrograms of arsenic per litre of urine.

Table 18b: Regression Coefficients - Total Urinary Arsenic and Occupational Exposure

Model		B	Std. Error	Beta	t	Sig.
Occup Exp	(Constant)	6.535	16.663		.392	.696
	Q6-work/exposed to chemicals	6.268E-02	.404	.016	.155	.877
	Q7-has any member worked at Deloro mine	1.534	8.258	.019	.186	.853

Dependent Variable: Total arsenic in micrograms of arsenic per litre of urine.

Table 19a: ANOVA Results - Speciated Urinary Arsenic and Occupational Exposure

Model		Sum of Squares	df	Mean Square	F	Sig.
Occup Exp	Regression	4.272	2	2.136	.076	.927
	Residual	2771.911	99	27.999		
	Total	2776.183	101			

R^2=.000

Predictors: (Constant), Q7 - has any member worked at Deloro mine, Q6 - work/exposed to chemicals.

Dependent Variable: Speciated non-dietary arsenic measured in micrograms of arsenic per litre of urine.

Table 19b: Regression Coefficients - Speciated Urinary Arsenic and Occupational Exposure

Model		B	Std. Error	Beta	t	Sig.
Occup Exp	(Constant)	3.954	5.066		.780	.437
	Q6-work/exposed to chemicals	-2.011E-02	.123	-.017	-.164	.870
	Q7-has any member worked at Deloro mine	-.966	2.511	-.040	-.385	.701

Dependent Variable: Speciated non-dietary arsenic measured in micrograms of arsenic per litre of urine.

Particular attention was given to the two residents who had levels of total arsenic above 150 micrograms per litre of urine. These individuals did not have any of the risk factors that could be associated with high arsenic levels. For example, neither of these individuals worked in the Deloro mine, did not swim or bathe in the Moira river, did not consume shell fish or other fish meals in the recent past, and were not exposed to chemicals at work. In addition, they did not report any adverse health effects.

Persons with detectable levels of speciated (inorganic) urinary arsenic levels were compared with those who had non-detectable levels. 15% (8/53) residents of Havelock had speciated arsenic detected, while only 12% (15/121) of Deloro residents had detectable levels of speciated arsenic.

The only variables that had a higher frequency among "the respondents who had detectable levels of speciated urinary arsenic" (n=23), compared to those respondents that did not (n=174), were related to the questions of:

- having eaten fish fillets or steaks once a month or more frequently (80% versus 46% respectively);
- having eaten fish meals in the past seven days (62% vs 25% respectively); and,
- having a vegetable garden (75% versus 47% respectively).

All the other variables either showed similar distributions or a lower frequency among respondents with detectable levels of speciated urinary arsenic compared to the rest.

In particular, a lower proportion of persons with nondetectable levels of urinary arsenic reported having been told of a health problem (42% versus 55% respectively). Persons with detectable levels of speciated urinary arsenic also took vitamins or other dietary supplements more regularly. Two of the respondents (9%, 2/23) with detectable levels and 12 respondents (7%, 12/174) with nondetectable levels swim or wade in Moira lake.

The six respondents who had speciated urinary arsenic of 15 μg/L or more did not report any of the potential risk factors any more frequently than the rest of the respondents.

4.6 Relationship of Environmental Arsenic with Urinary Arsenic

Arsenic in the environment of Deloro residents was assessed by environmental sampling of soil (including garden), water, indoor air and dust, and outdoor air, by other members of the contracted project team. Multivariate data analyses using multiple linear regression

modelling were carried out for further investigating the relationship of environmental arsenic with the urinary arsenic results (for both total and speciated urinary arsenic).

Detailed environmental sampling procedures are given in the project reports of the other members of the contract team. Briefly, these procedures encompassed the following:

- *surface soil* samples were collected from the front and back yards of all residential properties in the village of Deloro; to obtain representative soil samples, small plugs of soil were collected in a X or Z pattern across each yard; the resulting samples were analyzed for arsenic (amongst several other element analyses); ***depth soil*** samples were also taken at eight stations throughout the village of Deloro, locations where no recent disturbance were evident; as these latter samples resulted in no pattern in contaminant distribution (i.e., an overall mean value consistently represented most stations sampled), no further analysis was done with these data; further details are given in the Phytotoxicology 1998 Investigation Report No. SDB-056-3511-1998, MOE;

- *garden soil* samples were also collected in the village of Deloro; these soils were analyzed in the same way (and for the same elements) as the residential surface soils; although not known at the time of selection, the selected gardens were not located in the most contaminated areas of the village; this finding, when combined with the fact that the garden soil sampling went to a depth of 0-15 cm as compared to the surface soil sampling depth of 0-5 cm for residential properties, lead to significantly lower concentrations of metals, including environmental arsenic, in the garden soils than found in the soils collected from the surface for residential properties; further details are given in the Phytotoxicology 1998 Investigation Report No. SDB-056-3511-1998, MOE;

- *plants (vegetables)*, including beans, beets, carrots and lettuce, were planted from seed in these gardens on May 27, 1998 and harvested on July 29, 1998; the plants were chosen to represent root crops (carrots and beets) and leaf crops (lettuce). The beans were chosen because bean plants are known to be very sensitive to arsenic. These plants were analyzed and compared with a control set of plants for various elements, including environmental arsenic; further details are given in the Phytotoxicology 1998 Investigation Report No. SDB-056-3511-1998, MOE;

- *groundwater* samples from in-use private wells, along with the municipal well, were tested for various elements, including environmental arsenic; both first draw (i.e., early in the morning before residents used their wells) and flushed water (i.e., after a minimum running of the water tap for five minutes) samples were taken and analyzed; samples were obtained from an outside tap and hoses were removed where possible;

homes that had water treatment systems had such systems set to by-pass during the sampling period to permit collection of untreated samples; further details are given in the Summary Report of Air, Settled Dust, and Drinking Water Sampling and Analysis Activities, CG&S (January, 1999);

- ***indoor air and dust*** samples were taken in the village of Deloro, encompassing 55 households; air sampling pumps were set up on the main level near the common entranceway and in a common area, where occupants resided in the house, such as the living room or dining room; for households with children, one sample was acquired in the play area on the main floor of the dwelling; among various element analyses, environmental arsenic was measured in the indoor air samples; further details are given in the aforementioned CG&S report;

- as part of the ***dust*** sampling, ***indoor wipes***, ***indoor settled dust***, and ***bulk dust*** samples were taken in all Deloro households; for ***indoor wipes***, two sample areas were identified to determine surface dust on interior surfaces, whereupon duplicate wipe samples were acquired; for households with children, one sample was acquired on the main level of the household in the children's play area; for the ***indoor settled dust*** sampling procedure, two dust plates were used to sample settled house dust; the dust plates were set in place, side by side, for a target period of 30 +/- 2 days; these locations were chosen to minimize impact to the occupants and the potential for disturbance by children or pets; for ***bulk dust*** sampling, these samples were collected from settled dust plates for the 30-day period; typically, bulk dust samples were acquired from locations such as the top of the fridge in the kitchen or an elevated horizontal surface on the main level of the house; further details are given in the aforementioned CG&S report;

- ***outdoor air and dustfall*** samples were also taken at ten specific locations in/near the village of Deloro; locations were chosen based on inputs from CG&S, the MOE and other consultants involved in the study, and on resident permission and an available power source; for ***outdoor air***, samples were obtained at each location for a 24-hour sample over 10 days and analyzed for environmental arsenic amongst other elements; for ***outdoor dustfall***, samples were similarly acquired at each of the ten locations but over a thirty day period; road and exterior surface dust was also sampled in ten locations, following five days of dry weather in late October, 1998; samples were analyzed for environmental arsenic for both ***road dust and exterior surface dust*** (included road signs, mail boxes and a shed); further details are given in the aforementioned CG&S report.

In order to assess the relationship of arsenic detected in the various environmental media with the observed levels of arsenic in the urine of residents, a linear regression analysis was undertaken. The following sections deal with this analysis.

4.6.1 Surface Soil Data

Data files from CG&S contained the information on arsenic levels in the surface soil in the front yard and back yards of various residences in Deloro. The location of sampling was matched to the individual residences where urinary samples were available. All the residents in the same household were given the same value of surface soil arsenic.

Total Urinary Arsenic. A linear regression analysis revealed no significant association between total urinary arsenic and the surface soil arsenic levels. **Table 20** shows the ANOVA and the regression coefficients results for this model. The variation in urinary arsenic was not explained by either the front yard or the back yard surface soil levels.

Table 20a: ANOVA Results - Total Urinary Arsenic and Environmental Arsenic in Surface Soil

Model		Sum of Squares	df	Mean Square	F	Sig.
... Surf Soil	Regression	812.684	2	406.342	.976	.383
	Residual	23303.214	56	416.129		
	Total	24115.898	58			

$R^2 = 0.00$

Predictors: (Constant), BYARD, FYARD.

Dependent Variable: Total arsenic in micrograms of arsenic per litre of urine.

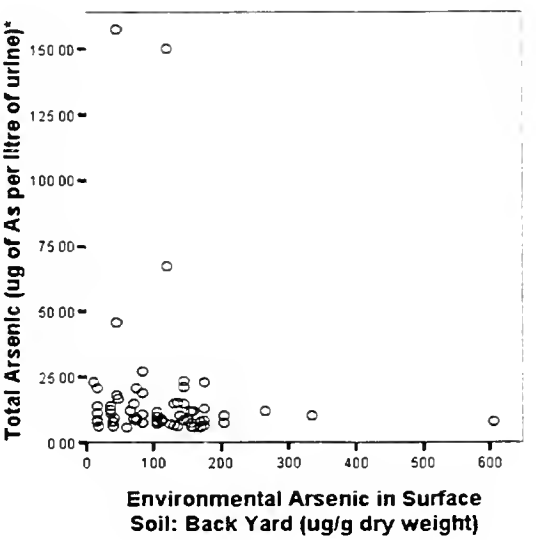
Table 20b: Regression Coefficients - Total Urinary Arsenic and Environmental Arsenic in Surface Soil

Model		B	Std. Error	Beta	t	Sig.
... Surf Soil	(Constant)	18.380	4.401		4.176	.000
	FYARD	-4.457E-02	.035	-.213	-1.291	.202
	BYARD	1.326E-02	.037	.059	.359	.721

Dependent Variable: Total arsenic in micrograms of arsenic per litre of urine.

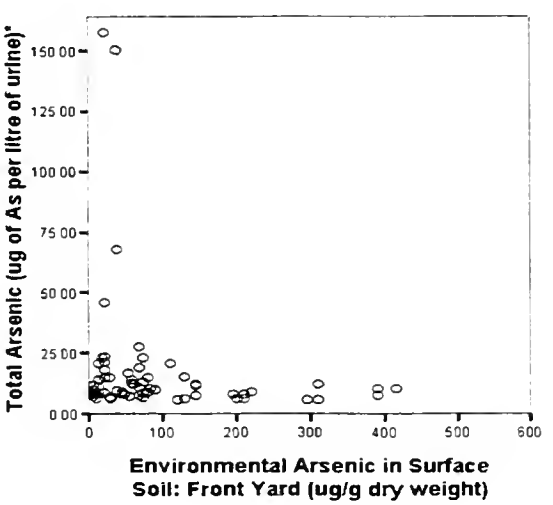
Figures 13 and 14 show the scatter plots for total urinary arsenic and the environment arsenic in surface soil in the back yard and front yard of Deloro residents respectively.

Figure 13: Scatter Plot for Total Urinary Arsenic and Environmental Arsenic in Surface Soil in Backyard of Deloro Residents



* assuming non-detectable urinary arsenic as 3 $\mu g/L$

Figure 14: Scatter Plot for Total Urinary Arsenic and Environmental Arsenic in Surface Soil in Front Yard of Deloro Residents



* assuming non-detectable urinary arsenic as 3 $\mu g/L$

From **Figures 13 and 14**, it can be seen that the two values of urinary arsenic above 150 micrograms per litre appear to be statistical outliers, and cause non-normality in the 'dependent' variable. This might make the regression analysis questionable (regardless of the use of various normalizing transformations). Accordingly, a separate analysis was done after removing these two values from the data set. This analysis did not result in any meaningful relationship between total urinary arsenic and environmental arsenic in the surface soil - for the back and front yards of Deloro residents. This analysis is not presented here.

Speciated (Inorganic) Urinary Arsenic. The scatter plots for speciated (inorganic) urinary arsenic and environmental arsenic in surface soil in the back yard and front yard of Deloro residents respectively, are given in **Figures 15 and 16**.

Table 21 shows the ANOVA and regression coefficients results for the linear regression of speciated arsenic on environmental arsenic in the surface soil of back and front yards of Deloro residents. No significant association between speciated urinary arsenic and the surface soil arsenic levels was found. The variation in urinary arsenic (only 1%) was not explained by either the front yard or the back yard surface soil levels.

Table 21a: ANOVA Results - Speciated Urinary Arsenic and Environmental Arsenic in Surface Soil

Model		Sum of Squares	df	Mean Square	F	Sig.
... Surf Soil	Regression	82.568	2	41.284	1.805	.169
	Residual	2813.672	123	22.875		
	Total	2896.240	125			

$R^2 = 0.01$

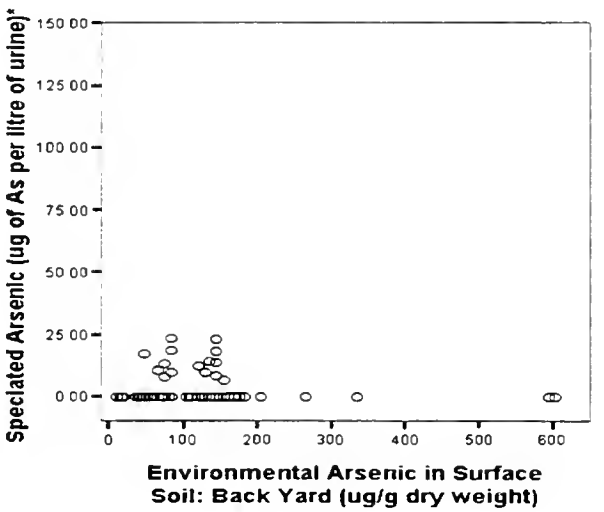
Predictors: (Constant), Front yard soil sample for arsenic, Back yard soil sample for arsenic.
Dependent Variable: Speciated (inorganic) arsenic measured in micrograms of arsenic per litre of urine.

Table 21b: Regression Coefficients - Speciated Urinary Arsenic and Environmental Arsenic in Surface Soil

Model		B	Std. Error	Beta	t	Sig.
... Surf Soil	(Constant)	2.273	.675		3.367	.001
	Back yard soil sample for arsenic	2.842E-03	.005	.064	.587	.559
	Front yard soil sample for arsenic	-9.189E-03	.005	-.198	-1.808	.073

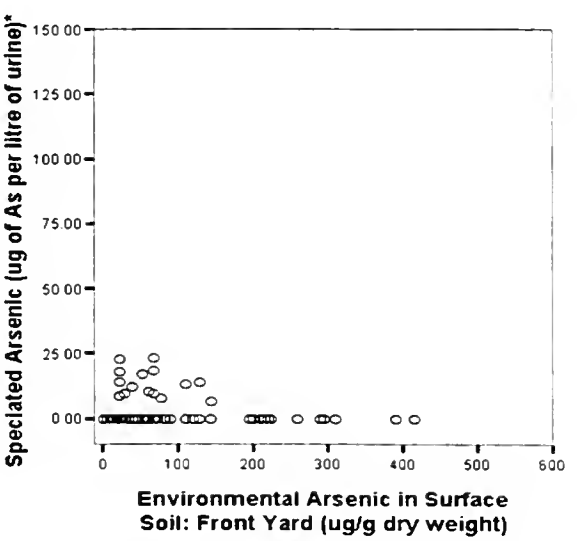
Dependent Variable: Speciated (inorganic) arsenic measured in micrograms of arsenic per litre of urine.

Figure 15: Scatter Plot for Speciated (inorganic) Urinary Arsenic and Environmental Arsenic in Surface Soil in Backyard of Deloro Residents



* assuming non-detectable urinary arsenic as 3 μg/L

Figure 16: Scatter Plot for Speciated (inorganic) Urinary Arsenic and Environmental Arsenic in Surface Soil in Front Yard of Deloro Residents



* assuming non-detectable urinary arsenic as 3 μg/L

As seen from the scatter plots (**Figures 15 and 16**) and the regression ANOVA (**Table 21**), there is no statistically significant association between speciated urinary arsenic and environmental arsenic in surface soil.

There is an appearance of a negative relationship between environmental arsenic in the surface soil of the front yard and urinary speciated arsenic. However, this relationship is not statistically significant ($P>0.05$), and is in a direction opposite to what was expected.

This apparent negative relationship is likely an artifact due to the few residents with detectable levels of urinary speciated arsenic from residences with low levels of environmental arsenic in surface soil of the front yard, and no residents with detectable level of urinary arsenic from residences with relatively high levels of environmental arsenic in the surface soil of the front yard. For these reasons, it is concluded that an increased level of environmental arsenic in surface soil of the front yard should be of no concern for the residents with respect to the level of speciated arsenic in their urine samples.

4.6.2 Soil in the Garden

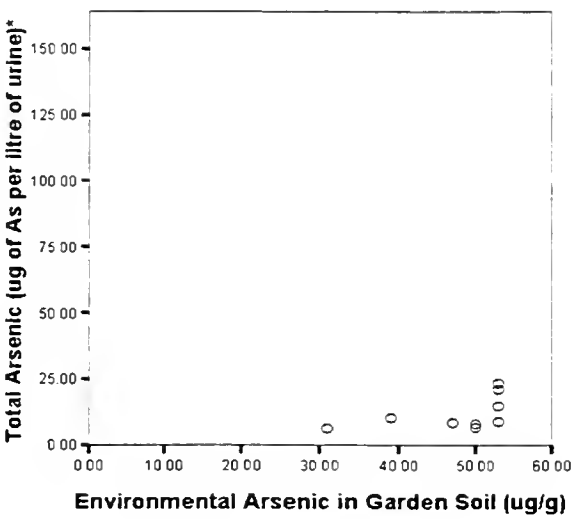
There were eight sample households where samples were taken from the ***soil in the garden*** and three plants (vegetables): ***bean pods, carrot roots, and lettuce leaves*** were analyzed for environmental arsenic. One of these households did not provide urine samples. Therefore, we have 7 samples where the level of environmental arsenic in the soil and plants in the garden could be analyzed for relationship with urinary arsenic.

The levels of environmental arsenic in the ***bean pods*** were all low (at the detection limit) and equal (0.2 μg/g). Therefore, no further analysis was done for the bean pods data.

The garden soil data had a mean of 49 μg/g dry weight (highest value, 65), the lettuce data had a mean of 1.3 μg/g (highest value, 3.5), and the carrot data had a mean of 0.7 μg/g (highest value, 2.0). Arsenic in the ***lettuce*** samples and the ***carrot*** samples did not correlate with the urinary arsenic (total or speciated). None of the regression coefficients (for garden soil, lettuce, or carrots) were statistically significant ($P>0.05$). The ANOVA/regression tables are not given here.

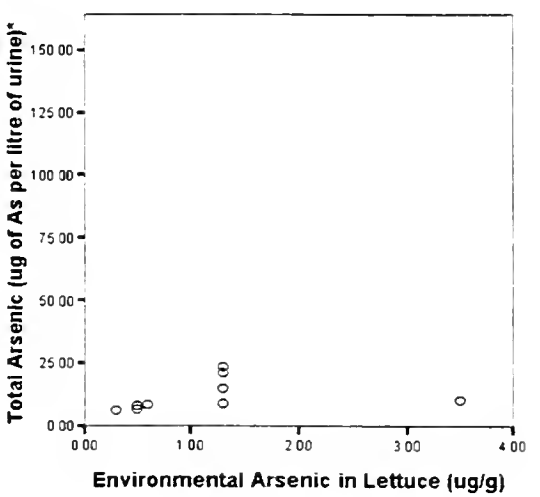
Figures 17, 18, and 19 show the scatter plots of environmental arsenic in the garden soil, lettuce and carrot samples with the total urinary arsenic. No relationships are evident from these displays.

Figure 17: Scatter Plot for Total Urinary Arsenic and Environmental Arsenic in Garden Soil of Deloro Residents



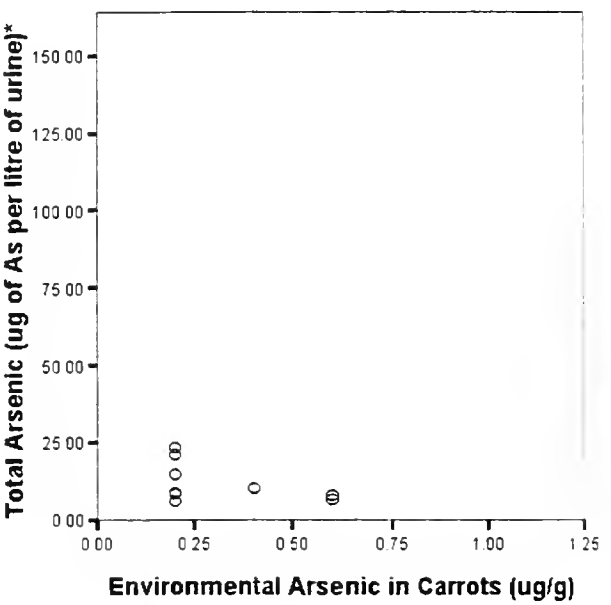
* assuming non-detectable urinary arsenic as 3 μg/L

Figure 18: Scatter Plot for Total Urinary Arsenic and Environmental Arsenic in Lettuce Leaves in Gardens of Deloro Residents



* assuming non-detectable urinary arsenic as 3 μg/L

Figure 19: Scatter Plot for Total Urinary Arsenic and Environmental Arsenic in Carrot Roots in Gardens of Deloro Residents



* assuming non-detectable urinary arsenic as 3 μg/L

4.6.3 Arsenic in Water

Water samples were taken from the households where the main source of water was a well. For the other households where the water supply was city supplied water, one sample was analyzed. All the samples had non-detectable levels of environmental arsenic. Therefore, no analysis is possible (nor required) to relate the water levels with urinary arsenic levels.

4.6.4 Arsenic in Indoor Air and Dust

Most of the sample values for indoor air and dust were below the detection limits. Therefore, an analysis of the relationship with urinary arsenic was not deemed feasible or meaningful.

4.6.5 Arsenic in Outdoor Air

The eight Deloro sampling sites for outdoor air were not directly identifiable with the households where urine samples were collected. Therefore, it was decided not to relate these measurements with urinary arsenic levels.

5.0 Discussion and Conclusions

Context. The survey included all residents of Deloro and a sample of residents from a community of comparable size and other characteristics (Havelock), except that it did not have a history of exposure to arsenic in the environment. Since the entire population of Deloro was included in the study, the results show a true picture of body burden of arsenic as measured by first void morning urine samples. As noted earlier, urinary arsenic tests are recognized in the medical community as the best method of measuring recent environmental exposure to arsenic. It is also the most sensitive for looking at low level exposures and the actual bodily dose to people. It is also the only method for which the health significance of the levels can be judged because some guidelines exist for total arsenic and there is information on speciated arsenic that can serve as a benchmark for health interpretation.

Coverage. The results above describe the characteristics of the population in Deloro. Since it was a complete census of residents of Deloro and represented at least 80% of the households/residents in the study, this report presents a statistically precise picture of the levels of urinary arsenic and other risk factors in this population.

Urinary Arsenic and Creatinine. Creatinine markers may assist in the assessment of diluteness of the urine. The first internal results from MAXXAM for the biological samples contrasted the analysis of total/speciated urinary arsenic - using urine creatinine - with that of the more traditional presentation of results in $\mu g/L$ (without urine creatinine). These results were examined by Goss Gilroy and the MOE and found to be quite similar in magnitude/interpretation. A literature review of urinary arsenic-based studies found previous studies using the traditional method of analysis. Therefore, creatinine markers were not used in the analysis of the report, because it will not change the findings of the study and adds to comparability with other published studies.

Follow-up of Residents. Two of the Deloro respondents showed a level of total arsenic above 150 micrograms per litre of urine. These values are above the normal range levels used by physicians when screening for acute arsenic poisoning. These persons were advised to visit their family physician for a subsequent test to verify the levels of arsenic in their urine and to take any actions to reduce these levels if necessary.

Similar observations hold true for respondents with potentially 'high' levels of speciated (inorganic) arsenic. It has been acknowledged in the literature that much of the total arsenic could be a measure of exposure to organic sources (e.g., seafish meal) and these possess no

danger to the health of the person. Speciated (inorganic) arsenic, identified in the literature as potential cause for concern, at least with respect to some acute symptoms and some chronic diseases, were detected in a very few of the respondents. It was this latter measure that was the main focus of the urinary arsenic analysis.

Nevertheless, three other residents (two in Deloro, one in Havelock) had levels of speciated (inorganic) urinary arsenic 20 micrograms per litre of urine or greater, and they too were advised to visit their family physician for subsequent testing to verify the levels of arsenic in their urine, and to take any actions to reduce these levels if necessary. The normal range level for speciated urinary arsenic is a subject of much international research today, and some experts have suggested a normal range level of 25 μg/L. Although no resident in the Deloro/Havelock study exceeded 25 μg/L, it was deemed prudent to invoke follow-up procedures nevertheless. In addition, comprehensive information packages were provided to each individual family physician.

In summary with respect to all of these follow-ups, ***it is emphasized that none of the five respondents - who were advised to seek additional testing by their family physician, showed any adverse health effects or unusual exposure to other environmental or dietary factors, based on their responses to the health risk questionnaire.*** In other words, there was nothing 'unusual' about these five individuals as far as the data that were collected in this study. No relationships to reported adverse health effects or other potential risk factors could be identified.

Comparison (Control) Community. In order to compare the arsenic levels and risk factors with a similar community that does not have an identified point source of arsenic contamination, the community of Havelock was selected. A random sample of individuals from this community was included in the survey with excellent response rate.

Deloro-Havelock Comparisons for Urinary Arsenic. Overall, the respondents from Havelock had similar urinary arsenic results to those results from Deloro, except that all the Havelock respondents had total arsenic well below the 150 μg/L observed for two individuals from Deloro. The average levels of urinary arsenic of residents from Deloro and Havelock were much less than the averages reported for other people exposed to significant sources of arsenic (such as mining/smelting, occupational, etc.) as reported in the scientific literature.

Statistical Comparisons and Results. Statistical comparison of the frequency distributions of urinary arsenic levels (total and speciated) and statistical tests of mean and median urinary arsenic levels showed no significant differences at the 5% significance level. ***It is***

therefore reasonable to conclude that residents of Deloro do not appear to have, on average, higher levels of arsenic (total and speciated) than the comparison (control) community.

Mean urinary arsenic levels (total as well as speciated) were compared for people reporting various health problems in the last year and these were found to be not significantly different. *It is therefore reasonable to conclude that the levels of arsenic in this community are not indicative of any excess levels of morbidity as observed by their self-reports.* The health problems reported in Deloro were similar to those reported from Havelock and appear similar to the general population.

Regression analysis showed that the urinary arsenic levels (total and speciated) could not be statistically associated with the characteristics of the population. Socio-demographic variables such as age, income and education were similar for various levels of urinary arsenic. None of the regression coefficients were significant.

Characteristics of the places of residence, including the presence of vegetable garden and use of well water as well as length of residence in Deloro were also analysed using a linear regression. None of the regression coefficients were statistically significant.

In addition, *the respondents with higher levels of arsenic were compared to those with lower levels and none of the variables showed statistically significant association.* Since there was no overall difference in mean arsenic levels between Deloro (exposed community) and Havelock (unexposed community), this result is expected.

Normally, in statistical modelling, various subgroups of independent variables are investigated separately and the ones found to be significant considered together in a final model. In this analysis, *since none of the separate regressions resulted in significant associations, a final model incorporating all the variables considered was not done.*

Data Limitations. Some of the variables were not considered in the regression analysis, due to the non-descriptive nature of the data or because of large number of missing observations (e.g., values below the detection limits). For example, the question on having a backyard was answered positively by almost all respondents and therefore would be non-informative. The question on consumption of shell-fish was answered only by a portion of the respondents and would have many missing values. One could assign a value of 'no consumption' to those who did not respond to the question and perform a regression analysis including this variable. This was not considered necessary, due to the relatively large number of separate analyses performed on the data set with no significant associations detected. Variables considered most reasonable to link with urinary arsenic were included in the separate analyses performed.

All the regression analyses were done using Deloro data only. This was primarily because the complementary and follow-up analyses using environmental data would include only the Deloro community. For comparability, it was considered appropriate to include only these data. Adding the Havelock data to the analysis would improve the statistical power, although 'village' will have to be included in the analysis as a separate independent variable (or, consider the two villages to be similar based on the univariate analysis comparing the mean arsenic levels). This type of (secondary) analysis was not performed as it would not substantially change any of the foregoing conclusions.

Overall Conclusions

There were no statistical difference in levels of arsenic in urine between Deloro and the comparison (control/unexposed) community of Havelock. Also, the levels of distribution of arsenic in urine in Deloro residents were very similar to those of Havelock.

The levels of arsenic in urine in Deloro are not indicative of any excess levels of illness (as observed by the Deloro/Havelock residents self-reporting).

There was no demonstrable relationship between arsenic levels in residential yards and garden soil and arsenic levels in urine.

Appendix A: Protocols for Collecting Urine Samples

Instructions for Collecting Urine Samples
Young Children who are using diapers

In addition to the Adult Sample Kit, the Child Sample Kit includes:

- ☞ ***a diaper insert (for children who have not yet begun to use a potty); looks like a plastic bag***

STEPS for diaper insert

1. At bedtime, put the diaper in place as instructed by the research team member.
2. Collect the urine that is in the insert in the morning.
3. Transfer the child's urine from the collector into the specimen bottle with his/her name.
4. IMPORTANT: if the quantity of urine collected is less than 50ml, keep the insert in place or change it for a new one to obtain the needed quantity
5. If the urine is collected during the night, place the bottle containing the sample in the refrigerator until morning. In the morning, put the sample in the box containing the ice pack.

IMPORTANT

- ★ 50 ml of urine is needed for each sample in order to do the analysis. This is about 1/3 of the bottle. If the amount collected the first time you use the washroom is less than 50 ml, then collect the amount missing the next time you use the washroom.
- ★ Be certain that family members use the correct bottle. Each bottle will have a personalized label.
- ★ Urine should be kept cool at all times.
- ★ If you have any questions, call Celine Pinsent at 1-800-611-0511

Instructions for Collecting Urine Samples
Adults and Older Children

Your Sample Kit includes:

- ☞ ***sterile bottles with name labels***
- ☞ ***an ice pack***
- ☞ ***a cooler bag***

STEPS

1. Place the ice pak in the freezer

2. Collect the urine from the first time you use the washroom in the morning

3. Use the labelled bottles provided for collecting the samples for each family member

4. Place the bottles containing the urine samples in the cooler bag with the ice pack

5. Put the cooler bag with the ice pack and the urine sample outside the house in the morning and a member of the research team will pick it up.

IMPORTANT

- ★ 50 ml of urine is needed for each sample in order to do the analysis. This is about 1/3 of the bottle. If the amount collected the first time you use the washroom is less than 50 ml, then collect the amount missing the next time you use the washroom.

- ★ Be certain that family members use the correct bottle. Each bottle will have a personalized label.

- ★ Urine should be kept cool at all times.

- ★ If you have any questions, call Celine Pinsent at 1-800-611-0511

Instructions for Collecting Urine Samples
Young Children who are toilet trained

In addition to the Adult Sample Kit, the Child Sample Kit includes:

- ☞ ***a toilet insert (for children who have begun to use a potty); looks like a potty***

STEPS for toilet insert

1. Place the toilet insert in the toilet seat as instructed by the researcher
2. Set the child on the toilet as normal
3. Collect the urine from the first time he/she uses the washroom in the morning
4. Transfer the child's urine from the collector into the specimen bottle with his/her name.
5. IMPORTANT: Use a new toilet insert for each child.

IMPORTANT

- ★ 50 ml of urine is needed for each sample in order to do the analysis. This is about 1/3 of the bottle. If the amount collected the first time you use the washroom is less than 50 ml, then collect the amount missing the next time you use the washroom.
- ★ Be certain that family members use the correct bottle. Each bottle will have a personalized label.
- ★ Urine should be kept cool at all times.
- ★ If you have any questions, call Celine Pinsent at 1-800-611-0511

GOSS GILROY INC.
Management Consultants/
Conseillers en gestion

Deloro Village Environmental Health Risk Study Questionnaire

Questionnaire No.

Household No.

Questionnaire _____ of _____

Deloro Village Environmental Health Risk Study Questionnaire

This interview is part of the wider study being conducted by the Ministry of the Environment. The purpose of the overall study is to measure environmental health risks in the Deloro area. The purpose of this part of the study, the health questionnaire and the collection of urine samples from residents, is to assess levels of arsenic in residents' urine and to assess any potential associated health risks. I will be asking you questions about all the residents in your household.

Section I - Demographic Information

1. Starting with yourself please list all people who live in this residence.

2. I now want to determine the household relationship of _____ to you.

3. **Verify Sex of Each Resident**

4. What is _____'s date of birth?

Section II - Adult Information

This Section Applies to Adults 16 Years Old or Older.

5. What is (your/his/her) current occupation? (If self-employed, specify)

6. Do you work with or are exposed to any chemicals?

7. Has any member ever worked at the Deloro mine?

Appendix B: Interview Questionnaire

Name	*Name*	*Name*	*Name*
_____	_____	_____	_____
❑1 Reference Person	❑1 Reference Person	❑1 Reference Person	❑1 Reference Person
❑2 Spouse	❑2 Spouse	❑2 Spouse	❑2 Spouse
❑3 Child	❑3 Child	❑3 Child	❑3 Child
❑4 Parent	❑4 Parent	❑4 Parent	❑4 Parent
❑5 Sister or Brother	❑5 Sister or Brother	❑5 Sister or Brother	❑5 Sister or Brother
❑6 Other Relative	❑6 Other Relative	❑6 Other Relative	❑6 Other Relative
❑7 Roomer or Boarder	❑7 Roomer or Boarder	❑7 Roomer or Boarder	❑7 Roomer or Boarder
❑1 Male	❑1 Male	❑1 Male	❑1 Male
❑2 Female	❑2 Female	❑2 Female	❑2 Female
__ __ __ __ __ __	__ __ __ __ __ __	__ __ __ __ __ __	__ __ __ __ __ __
month day year	month day year	month day year	month day year
Occupation	Occupation	Occupation	Occupation
_____ __ __	_____ __ __	_____ __ __	_____ __ __
❑1 yes	❑1 yes	❑1 yes	❑1 yes
❑2 no	❑2 no	❑2 no	❑2 no
❑3 don't know	❑3 don't know	❑3 don't know	❑3 don't know
❑1 yes	❑1 yes	❑1 yes	❑1 yes
❑2 no	❑2 no	❑2 no	❑2 no
❑3 don't know	❑3 don't know	❑3 don't know	❑3 don't know

Job #1 (Starting with the most recent)

8. a) What is/was (your/his/her) job title?

   b) How long have (you/he/she) worked there?

   c) Do(es)/Did (you/he/she) change out of (your/his/her) work clothes and leave them at work?

   d) Do(es)/Did (you/he/she) shower at work before coming home)?

Job #2 (Previous to Job #1)

9. a) What is/was (your/his/her) job title?

   b) How long have (you/he/she) worked there?

   c) Do(es)/Did (you/he/she) change out of (your/his/her) work clothes and leave them at work?

   d) Do(es)/Did (you/he/she) shower at work before coming home)?

Job #3 (Previous to Job #2)

10. a) What is/was (your/his/her) job title?

    b) How long have (you/he/she) worked there?

    c) Do(es)/Did (you/he/she) change out of (your/his/her) work clothes and leave them at work?

<table>
<tr><th>Name
____________________</th><th>Name
____________________</th><th>Name
____________________</th><th>Name
____________________</th></tr>
<tr><td>❑1 yes
❑2 no
❑3 don't know
❑4 not applicable</td><td>❑1 yes
❑2 no
❑3 don't know
❑4 not applicable</td><td>❑1 yes
❑2 no
❑3 don't know
❑4 not applicable</td><td>❑1 yes
❑2 no
❑3 don't know
❑4 not applicable</td></tr>
<tr><td>❑1 yes → at present ❑1
→ in the past but not now ❑2
→ never ❑3
→ don't know ❑4
❑2 no</td><td>❑1 yes → at present ❑1
→ in the past but not now ❑2
→ never ❑3
→ don't know ❑4
❑2 no</td><td>❑1 yes → at present ❑1
→ in the past but not now ❑2
→ never ❑3
→ don't know ❑4
❑2 no</td><td>❑1 yes → at present ❑1
→ in the past but not now ❑2
→ never ❑3
→ don't know ❑4
❑2 no</td></tr>
<tr><td>❑1 yes
❑2 no
❑3 don't know
|__ __|__ __|
no. per day</td><td>❑1 yes
❑2 no
❑3 don't know
|__ __|__ __|
no. per day</td><td>❑1 yes
❑2 no
❑3 don't know
|__ __|__ __|
no. per day</td><td>❑1 yes
❑2 no
❑3 don't know
|__ __|__ __|
no. per day</td></tr>
<tr><td>❑1 yes
❑2 no
❑3 don't know
|__ __|__ __|
no. per day</td><td>❑1 yes
❑2 no
❑3 don't know
|__ __|__ __|
no. per day</td><td>❑1 yes
❑2 no
❑3 don't know
|__ __|__ __|
no. per day</td><td>❑1 yes
❑2 no
❑3 don't know
|__ __|__ __|
no. per day</td></tr>
<tr><td>❑1 yes
❑2 no
❑3 don't know
|__ __|__ __|
no. per day</td><td>❑1 yes
❑2 no
❑3 don't know
|__ __|__ __|
no. per day</td><td>❑1 yes
❑2 no
❑3 don't know
|__ __|__ __|
no. per day</td><td>❑1 yes
❑2 no
❑3 don't know
|__ __|__ __|
no. per day</td></tr>
<tr><td>❑1 yes
❑2 no
❑3 don't know
|__ __|__ __|
no. per day</td><td>❑1 yes
❑2 no
❑3 don't know
|__ __|__ __|
no. per day</td><td>❑1 yes
❑2 no
❑3 don't know
|__ __|__ __|
no. per day</td><td>❑1 yes
❑2 no
❑3 don't know
|__ __|__ __|
no. per day</td></tr>
<tr><td>|__ __|__ __| years
(00 if less than one year)</td><td>|__ __|__ __| years
(00 if less than one year)</td><td>|__ __|__ __| years
(00 if less than one year)</td><td>|__ __|__ __| years
(00 if less than one year)</td></tr>
<tr><td>❑1 yes
❑2 no</td><td>❑1 yes
❑2 no</td><td>❑1 yes
❑2 no</td><td>❑1 yes
❑2 no</td></tr>
<tr><td>❑1 north of the Deloro Dam (river)
❑2 south of the mine site property (river)
❑3 Moira Lake</td><td>❑1 north of the Deloro Dam (river)
❑2 south of the mine site property (river)
❑3 Moira Lake</td><td>❑1 north of the Deloro Dam (river)
❑2 south of the mine site property (river)
❑3 Moira Lake</td><td>❑1 north of the Deloro Dam (river)
❑2 south of the mine site property (river)
❑3 Moira Lake</td></tr>
</table>

13. What was (his/her) highest grade or diploma finished in school?

Section III - Child Environment for Children Under 16

The next few questions are related to the health and play environment of the children. Some of these questions are for very young children and may not be applicable to your children.

14. Are _____'s hands usually washed before eating?

15. Are _____'s hands and face usually washed before going to sleep?

16. ***For young children under 8 ask:*** Does your child eat dirt or chew on toys or other objects?

17. ***For children under 2 ask:*** Was _____ breastfed at any point?

18. About how many hours each day on the average does (he/she) spend away from home?

    If 3 or more, probe "where"

19. Where is _____'s favourite ***outdoor*** play area?

20. What percentage of the ground in his (her) favourite area is bare, unsodded ground, for example, dirt, sand or gravel?

21. How many hours each day does (he/she) usually spend playing outdoors in the summer?

22. Where is _____ favourite indoor play area?

Name	*Name*	*Name*	*Name*
❑$_1$ carpet ❑$_2$ linoleum ❑$_3$ hardwood ❑$_4$ tile ❑$_5$ other (specify)	❑$_1$ carpet ❑$_2$ linoleum ❑$_3$ hardwood ❑$_4$ tile ❑$_5$ other (specify)	❑$_1$ carpet ❑$_2$ linoleum ❑$_3$ hardwood ❑$_4$ tile ❑$_5$ other (specify)	❑$_1$ carpet ❑$_2$ linoleum ❑$_3$ hardwood ❑$_4$ tile ❑$_5$ other (specify)
__ __ hours a day	__ __ hours a day	__ __ hours a day	__ __ hours a day
❑$_1$ yes ❑$_2$ no	❑$_1$ yes ❑$_2$ no	❑$_1$ yes ❑$_2$ no	❑$_1$ yes ❑$_2$ no

27. In the last week (7 days) what fish meals have you eaten? *(Include both freshwater and saltwater fish meals)*

❑$_1$ No fish meals eaten in last 7 days

Date	Species/Type	Where was it caught/purchased	Number of Meals

Comments: _____

_____

28. Do all family members eat these meals?

29. a) Do you catch fish from the Moira River or Lake?

b) If ***yes***, where?

30. a) Do you east fish from the Moira River or Lake (whether you or someone else caught it)?

b) If ***yes***, how often?

31. We would like to know if you have ever been told by a doctor that you had (or have) any of the following health problems:

Name	Name	Name	Name
_____	_____	_____	_____
❑1 yes ❑2 no → Go to Q.33	❑1 yes ❑2 no → Go to Q.33	❑1 yes ❑2 no → Go to Q.33	❑1 yes ❑2 no → Go to Q.33
Medication ❑1 _____ ❑2 _____ ❑3 _____ ❑4 _____	Medication ❑1 _____ ❑2 _____ ❑3 _____ ❑4 _____	Medication ❑1 _____ ❑2 _____ ❑3 _____ ❑4 _____	Medication ❑1 _____ ❑2 _____ ❑3 _____ ❑4 _____
Dosage ❑1 _____ ❑2 _____ ❑3 _____ ❑4 _____ ❑5 _____	Dosage ❑1 _____ ❑2 _____ ❑3 _____ ❑4 _____ ❑5 _____	Dosage ❑1 _____ ❑2 _____ ❑3 _____ ❑4 _____ ❑5 _____	Dosage ❑1 _____ ❑2 _____ ❑3 _____ ❑4 _____ ❑5 _____
Length of Time ❑1 _____ ❑2 _____ ❑3 _____ ❑4 _____	Length of Time ❑1 _____ ❑2 _____ ❑3 _____ ❑4 _____	Length of Time ❑1 _____ ❑2 _____ ❑3 _____ ❑4 _____	Length of Time ❑1 _____ ❑2 _____ ❑3 _____ ❑4 _____
❑1 yes → which type_____ ❑2 no	❑1 yes → which type_____ ❑2 no	❑1 yes → which type_____ ❑2 no	❑1 yes → which type_____ ❑2 no
❑1 yes ❑2 no ❑3 don't know	❑1 yes ❑2 no ❑3 don't know	❑1 yes ❑2 no ❑3 don't know	❑1 yes ❑2 no ❑3 don't know
❑1 yes → which type_____ ❑2 no	❑1 yes → which type_____ ❑2 no	❑1 yes → which type_____ ❑2 no	❑1 yes → which type_____ ❑2 no
____ ft ___inches *OR* ___meters	____ ft ___inches *OR* ___meters	____ ft ___inches *OR* ___meters	____ ft ___inches *OR* ___meters
____ pounds *OR* ____ kilograms	____ pounds *OR* ____ kilograms	____ pounds *OR* ____ kilograms	____ pounds *OR* ____ kilograms
❑1 yes ❑2 lost weight → ___lbs/kgs ❑3 gained weight→ __lbs/kgs	❑1 yes ❑2 lost weight → ___lbs/kgs ❑3 gained weight→ __lbs/kgs	❑1 yes ❑2 lost weight → ___lbs/kgs ❑3 gained weight→ __lbs/kgs	❑1 yes ❑2 lost weight → ___lbs/kgs ❑3 gained weight→ __lbs/kgs

Section V - House Characteristics Related to Exposure

36. How long have you lived in Deloro?

37. a) Has _____ lived at another address for more than three weeks during 1998?

b) Where did he/she live?

c) When did he/she live there?

38. ***(Observe)*** House or Apartment?

- ❑$_1$ house
- ❑$_2$ apartment in a building with less than 5 storeys
- ❑$_3$ apartment in a building with 5 storeys or more

39. How long have you lived in this residence? |__ __|__ __| years

If less than one year:

Where did you live previously? _____

How many years? |__ __|__ __| years

40. When was the house or apartment building originally built?

- ❑$_1$ before 1945
- ❑$_2$ between 1945 and 1955
- ❑$_3$ between 1955 and 1965
- ❑$_4$ after 1965
- ❑$_5$ don't know

41. Have any of the following been done to the inside or outside of your home in the past year?

a) added or taken away walls, floors, windows, or rooms?

- ❑$_1$ yes
- ❑$_2$ no
- ❑$_3$ don't know

Name	Name	Name	Name
_____	_____	_____	_____
Title	Title	Title	Title
_____ |_ _|	_____ |_ _|	_____ |_ _|	_____ |_ _|
|_ _| |_ _| years months	|_ _| |_ _| years months	|_ _| |_ _| years months	|_ _| |_ _| years months
❑1 yes ❑2 no ❑3 don't know ❑4 not applicable	❑1 yes ❑2 no ❑3 don't know ❑4 not applicable	❑1 yes ❑2 no ❑3 don't know ❑4 not applicable	❑1 yes ❑2 no ❑3 don't know ❑4 not applicable
❑1 yes ❑2 no ❑3 don't know ❑4 not applicable	❑1 yes ❑2 no ❑3 don't know ❑4 not applicable	❑1 yes ❑2 no ❑3 don't know ❑4 not applicable	❑1 yes ❑2 no ❑3 don't know ❑4 not applicable
Title	Title	Title	Title
_____ |_ _|	_____ |_ _|	_____ |_ _|	_____ |_ _|
|_ _| |_ _| years months	|_ _| |_ _| years months	|_ _| |_ _| years months	|_ _| |_ _| years months
❑1 yes ❑2 no ❑3 don't know ❑4 not applicable	❑1 yes ❑2 no ❑3 don't know ❑4 not applicable	❑1 yes ❑2 no ❑3 don't know ❑4 not applicable	❑1 yes ❑2 no ❑3 don't know ❑4 not applicable
❑1 yes ❑2 no ❑3 don't know ❑4 not applicable	❑1 yes ❑2 no ❑3 don't know ❑4 not applicable	❑1 yes ❑2 no ❑3 don't know ❑4 not applicable	❑1 yes ❑2 no ❑3 don't know ❑4 not applicable
Title	Title	Title	Title
_____ |_ _|	_____ |_ _|	_____ |_ _|	_____ |_ _|
|_ _| |_ _| years months	|_ _| |_ _| years months	|_ _| |_ _| years months	|_ _| |_ _| years months
❑1 yes ❑2 no ❑3 don't know ❑4 not applicable	❑1 yes ❑2 no ❑3 don't know ❑4 not applicable	❑1 yes ❑2 no ❑3 don't know ❑4 not applicable	❑1 yes ❑2 no ❑3 don't know ❑4 not applicable

d) Do(es)/Did (you/he/she) shower at work before coming home)?

11. a) Does he/she smoke?

IF PRESENT OR PAST SMOKER: **What type of smoking (is/was) done?** ***(Fill in all that Apply)***

b) cigarettes

c) cigars

d) pipes

e) other

IF PAST SMOKER: **(2 above)**

f) How long ago did he/she quit?

12. a) Do you swim/wade in the Moira River or Lake?

b) If ***Yes***, where?

Name

____

level

_______________ |__|__|

❑$_1$ yes
❑$_2$ no
❑$_3$ don't know

❑$_1$ yes
❑$_2$ no
❑$_3$ don't know

❑$_1$ yes
❑$_2$ no
❑$_3$ don't know

❑$_1$ yes
❑$_2$ no ➜ Go to Q.18
If yes,
Fow how long? __________
When did/she stop? ______

|__|__| hours a day

❑$_1$ school/daycare
❑$_2$ elsewhere (specify)
____

Play Area
_______________ |__|__|

|__|__|__| %

|__|__| hours a day

Play Area
_______________ |__|__|

Name

____

level

_______________ |__|__|

❑$_1$ yes
❑$_2$ no
❑$_3$ don't know

❑$_1$ yes
❑$_2$ no
❑$_3$ don't know

❑$_1$ yes
❑$_2$ no
❑$_3$ don't know

❑$_1$ yes
❑$_2$ no ➜ Go to Q.18
If yes,
Fow how long? __________
When did/she stop? ______

|__|__| hours a day

❑$_1$ school/daycare
❑$_2$ elsewhere (specify)
____

Play Area
_______________ |__|__|

|__|__|__| %

|__|__| hours a day

Play Area
_______________ |__|__|

Name

____

level

_______________ |__|__|

❑$_1$ yes
❑$_2$ no
❑$_3$ don't know

❑$_1$ yes
❑$_2$ no
❑$_3$ don't know

❑$_1$ yes
❑$_2$ no
❑$_3$ don't know

❑$_1$ yes
❑$_2$ no ➜ Go to Q.18
If yes,
Fow how long? __________
When did/she stop? ______

|__|__| hours a day

❑$_1$ school/daycare
❑$_2$ elsewhere (specify)
____

Play Area
_______________ |__|__|

|__|__|__| %

|__|__| hours a day

Play Area
_______________ |__|__|

Name

____

level

_______________ |__|__|

❑$_1$ yes
❑$_2$ no
❑$_3$ don't know

❑$_1$ yes
❑$_2$ no
❑$_3$ don't know

❑$_1$ yes
❑$_2$ no
❑$_3$ don't know

❑$_1$ yes
❑$_2$ no ➜ Go to Q.18
If yes,
Fow how long? __________
When did/she stop? ______

|__|__| hours a day

❑$_1$ school/daycare
❑$_2$ elsewhere (specify)
____

Play Area
_______________ |__|__|

|__|__|__| %

|__|__| hours a day

Play Area
_______________ |__|__|

23. What type of flooring is in this area?

24. How many hours each day does he/she usually spend playing indoors in the summer?

Section IV - Family Diet and Health

25. How often in the past 12 months has the family eaten oceanfish and seafood, that is, fish or seafood from the oceans or open seas such as haddock, cod, tuna, sole, shrimp, lobster, etc. Do not include here any of the fish from the Great Lakes, St. Lawrence or any other inland lakes or rivers. We are interested in all ocean fish and seafood: that was bought in stores, in restaurants, from take-outs, eaten at home etc.

Type of Salt-Water Fish Eaten	Number of Times eaten in the last 12 months			Comments
	Per Week	Per Month	Per Year	
Fillets or Steaks - fresh, frozen, salted (cod, halibut, sole, haddock, ocean salmon etc.)				
Frozen Fish Sticks or Fish Dinners				
Shellfish (lobster, crab, shrimp, scallops, oysters, clams, mussels)				
Canned Fish (tuna, salmon, sardines)				
Whole Fish - fresh or frozen (herring, mackerel, sea smelts)				
Caviar/fish roe				
Other: (Please specify) a. _____ b. _____ c. _____				

26. Do all family members eat these meals?

Name	Name	Name	Name
______________	______________	______________	______________
☐1 yes ☐2 no	☐1 yes ☐2 no	☐1 yes ☐2 no	☐1 yes ☐2 no
☐1 yes ☐2 no	☐1 yes ☐2 no	☐1 yes ☐2 no	☐1 yes ☐2 no
☐1 north of the Deloro Dam (river) ☐2 south of the mine site property (river) ☐3 Moira Lake	☐1 north of the Deloro Dam (river) ☐2 south of the mine site property (river) ☐3 Moira Lake	☐1 north of the Deloro Dam (river) ☐2 south of the mine site property (river) ☐3 Moira Lake	☐1 north of the Deloro Dam (river) ☐2 south of the mine site property (river) ☐3 Moira Lake
☐1 yes ☐2 no	☐1 yes ☐2 no	☐1 yes ☐2 no	☐1 yes ☐2 no
______________ |__|__|	______________ |__|__|	______________ |__|__|	______________ |__|__|
☐1 high cholesterol ☐2 diabetes ☐3 liver disease ☐4 gastrointestinal problems (specify)__________ ☐5 skin cancer ☐6 lung cancer ☐7 bladder cancer ☐8 skin rashes or lesions describe __________ ______________ ______________ ☐9 any other cancer (specify) ______________ ☐10 other (specify) ______________	☐1 high cholesterol ☐2 diabetes ☐3 liver disease ☐4 gastrointestinal problems (specify)__________ ☐5 skin cancer ☐6 lung cancer ☐7 bladder cancer ☐8 skin rashes or lesions describe __________ ______________ ______________ ☐9 any other cancer (specify) ______________ ☐10 other (specify) ______________	☐1 high cholesterol ☐2 diabetes ☐3 liver disease ☐4 gastrointestinal problems (specify)__________ ☐5 skin cancer ☐6 lung cancer ☐7 bladder cancer ☐8 skin rashes or lesions describe __________ ______________ ______________ ☐9 any other cancer (specify) ______________ ☐10 other (specify) ______________	☐1 high cholesterol ☐2 diabetes ☐3 liver disease ☐4 gastrointestinal problems (specify)__________ ☐5 skin cancer ☐6 lung cancer ☐7 bladder cancer ☐8 skin rashes or lesions describe __________ ______________ ______________ ☐9 any other cancer (specify) ______________ ☐10 other (specify) ______________

32. a) Are you currently using prescription drugs (***women only*** - including contraceptives)?

b) If ***Yes,*** please list the prescription drugs that you are currently taking, the dosage of the drug, and the length of time you have been taking the medicine:

c) Are you current taking any other types of medication?

33. During the last three months, has _____ been taking any vitamins, minerals, or other dietary supplements?

34. Are you currently on any specialized diet prescribed by your physician?

35. a) What is your present height?

b) What is your present weight?

c) Have you lost or gained any weight in the last 6 months?

Name	*Name*	*Name*	*Name*
_____	_____	_____	_____
__ __ years __ __ months	__ __ years __ __ months	__ __ years __ __ months	__ __ years __ __ months
❑1 yes ❑2 no ❑3 don't know	❑1 yes ❑2 no ❑3 don't know	❑1 yes ❑2 no ❑3 don't know	❑1 yes ❑2 no ❑3 don't know
_____ __ __	_____ __ __	_____ __ __	_____ __ __
From: __ __ __ __ (day mth) To: __ __ __ __ (day mth)	From: __ __ __ __ (day mth) To: __ __ __ __ (day mth)	From: __ __ __ __ (day mth) To: __ __ __ __ (day mth)	From: __ __ __ __ (day mth) To: __ __ __ __ (day mth)

b) replaced drywall?

- ❑1 yes
- ❑2 no
- ❑3 don't know

c) added insulation?

- ❑1 yes
- ❑2 no
- ❑3 don't know

d) any other renovation?

- ❑1 yes
- ❑2 no
- ❑3 don't know

If yes, describe:

Describe Renovation: _____

Do Not Read

- ❑1 painting
- ❑2 wallpaper
- ❑3 outside work
- ❑4 major or minor construction
- ❑5 other (carpeting, electrical...)
- ❑6 painting and other
- ❑7 painting ***and*** major or minor construction
- ❑8 other (specify) _____

42. What type of heating does your house or apartment have? (Ask for primary heating)

Do Not Read

- ❑1 gas
- ❑2 oil
- ❑3 electricity
- ❑4 wood
- ❑5 heat pump
- ❑6 gas and electricity
- ❑7 other (specify) _____
- ❑8 don't know

43. Does your house or apartment have:

a) a fireplace?

❑$_1$ yes and used
❑$_2$ no
❑$_3$ yes, but never used
❑$_4$ don't know

b) forced air (a fan on the furnace)?

❑$_1$ yes ➜ Go to Q.43c
❑$_2$ no ➜ Go to Q.43d
❑$_3$ not applicable
❑$_4$ don't know

c) an air filter on the furnace?

❑$_1$ yes
❑$_2$ no
❑$_3$ not applicable
❑$_4$ don't know

d) an air cleaner (for example, desk top, ionizer, etc.)?

❑$_1$ yes
❑$_2$ no
❑$_3$ don't know

e) an air conditioner?

❑$_1$ yes
❑$_2$ no
❑$_3$ don't know

44. a) Do you have a yard?

❑$_1$ yes
❑$_2$ no ➜ Go to Q.45
❑$_3$ don't know

b) Are there patches without grass?

❑$_1$ yes
❑$_2$ no
❑$_3$ not applicable
❑$_4$ don't know

Section VI - Family/Lifestyle Characteristics Related to Exposure

The next few questions are about our family's general activities.

45. a) Do you have a garden?

- ❑$_1$ yes
- ❑$_2$ no → Go to Q.46
- ❑$_3$ don't know

If yes:

b) In it, do you grow:

- ❑$_1$ vegetables
- ❑$_1$ fruit
- ❑$_2$ flowers
- ❑$_3$ both
- ❑$_4$ neither
- ❑$_5$ don't know

If no fruit or vegetable garden, go to Q.46

If you grow fruit or vegetables:

c) Did you eat fruit or vegetables from your garden this summer?

- ❑$_1$ yes
- ❑$_2$ no → Go to Q.46
- ❑$_3$ don't know

If yes:

d) How often?

- ❑$_1$ once a week or more
- ❑$_2$ between once a week and once a month
- ❑$_3$ less often than once a month
- ❑$_4$ don't know

46. a) Have you applied any pesticides to your garden and/or lawn?

- ❑$_1$ yes
- ❑$_2$ no
- ❑$_3$ don't know

b) If ***yes***, what pesticides have been applied?

(specify) _____

_____

47. a) Do you have a groundwater well on your property?

- ❑$_1$ yes
- ❑$_2$ no
- ❑$_3$ don't know

b) If ***yes***, what is the well water used for?

- ❑$_1$ drinking
- ❑$_2$ bathing/showering
- ❑$_3$ gardening

48. a) Do you have any pets at home?

- ❑$_1$ yes
- ❑$_2$ no
- ❑$_3$ don't know

If yes:

b) number of cats |__ __|__ __|

c) number of dogs |__ __|__ __|

d) other _____

- ❑$_1$ rabbit, rat, guinea pig
- ❑$_2$ bird
- ❑$_3$ fish, frog, turtle
- ❑$_4$ 1 + 2
- ❑$_5$ 2 + 3
- ❑$_6$ + 2 + 3
- ❑$_7$ 1 + 3
- ❑$_8$ Other _____
- ❑$_9$ don't know

49. a) Is your pet allowed to go outside?

- ❑$_1$ yes
- ❑$_2$ no

b) If ***yes,*** how long does it spend outside?

- ❑$_1$ most of the day (10+ hours)
- ❑$_2$ some of the day (less than 10 hours)
- ❑$_3$ rarely (less than 1 hour)

50. And finally, so that we can compare answers across groups of similar people, I would like to ask you a question about income because income may be related to health. I don't need to know the exact figure, but could you tell me which of the following broad categories your **total annual household income (before tax) for 1997,** from all sources, falls into. I will read the list but please stop me when I reach your category.

Read List

- ❑$_1$ under $10,000
- ❑$_2$ $10,000 - $20,000
- ❑$_3$ $20,000 - $30,000
- ❑$_4$ $30,000 - $40,000
- ❑$_5$ $40,000 - $50,000
- ❑$_6$ Over $50,000
- ❑$_7$ refuse to answer
- ❑$_8$ don't know

Thank you very much for your assistance. We greatly appreciate your time and cooperation in helping us.

Do you have any comments or any questions you would like to ask me?

_____

_____

_____

Future Contact

Name: _____

Phone #: _____

Appendix C: Other Relevant Documents

MEMO

To: Lisa Mendonça
Project Manager
CH2M Gore & Storrie Limited

From: Tom Goss
Partner
Goss Gilroy Inc.

Subject: Village of Deloro Health Risk Study - Comments on Draft Report

Date: July 12, 1999

This memo is our formal response to your two recently received letters by reviewers of our March 10, Final Draft Report; namely, the letter dated June 28th, 1999 (*"Comments on Draft Report and Public Information Session"*) and the letter dated July 9th, 1999 (*"Additional Comments on Draft Report"*).

Overall, the comments that were considered must dos totalled four (4), but upon further analysis, one (1) is clearly not related to our Report (rather it is a comment on the Cantox report). Therefore, we have addressed the three (3) applicable reviewers' comments herein.

In addition, many comments were marked for our consideration (optional), and we decided to address most of these comments to ensure the utmost clarity in our Report. Also, our additional comments may aid the overall dissemination process of the study itself.

Our responses reflect the consensus view of our internal research team consisting of: Dr. Rama Nair, Celine Pinsent, and Dr. Tom Goss.

Specific Responses to Reviewers' Comments

From June 28, 1999 Letter -

* - "The method for the analysis of urinary arsenic has poor sensitivity. With a poor detection limit of 6 μg/L for total urinary arsenic .... This resulted in 'large number of missing observations', a limitation recognized by the report (p.49)."

> **Our response**: Because less than 6 μg/L is not considered a health risk and is well below the "normal range levels", therefore, being unable to detect this level of arsenic is not

important from a health perspective. Hence, the reviewer's use of the term "poor sensitivity" may be misleading for characterizing the method used for the analysis of urinary arsenic. For example, even if a method had been available and employed that would have resulted in the use of a much lower detection limit, say 1 μg/L, the findings in our study would NOT have changed.

* - "The methods for the determination of urinary arsenic are not described. It is not clear whether the 'speciated (inorganic) arsenic' is the sum of inorganic arsenite and ... species."

Our response: The methodology used in our urinary arsenic analyses was not attached to our Report because of confidentiality requirements (i.e., the protocols were developed by MAXXAM, a private lab). However, at the outset of the study, these specific methods employed by MAXXAM Analytics Inc. (Occupational Health Sciences Lab, Etobicoke, Ontario) in the urinary arsenic analyses were examined in detailed by our internal research team, including the scientific experts at the MOE. We are unable to make this document public.

* - "1. Executive Summary, page v: The second sentence says that 'the threshold approach applies to the non-carcinogenic effects of a metal. ... Arbitrary."

Our response: This comment is not related to our Report (we believe it is from the Cantox report, but not for certain). No action taken.

* - "2. Page 3-3, 4th paragraph under Urinary Arsenic Results: My concern here is similar to the one above. The fact that none of the five respondents showed any adverse health effect based on their responses to the health risk questionnaire is very hard to interpret because it depends on how sensitive the questionnaire is (i.e., whether the "right" questions were asked) and how the respondents interpreted the questions (NB: I have not seen the questionnaire and I do not know how it was administrated so this concern may not be valid)."

Our response: This comment again refers mainly to another consultant's report. However, the reference and comments made on the use of the health risk questionnaire need to be addressed. (Note: I doubt this would be necessary had the reviewer seen our questionnaire and accompanying documentation). Both the validity and reliability of all questions were determined at the outset of the study and fully approved by the MOE advisors before proceeding with the implementation stage. For example, our health risk questionnaire was based on the standard approach to such epidemiological studies, using a rigourous questionnaire development process that included: inputs from a broad-based research team, use of previously tested health risk questions wherever possible, full pre-testing of all questions before actual implementation, and careful control and monitoring of all specific implementation steps, procedures, and results obtained by the well-trained interview team.

√ - "In sections 4.2, 4.5, and 5.0 of the report Goss Gilroy Inc. characterizes ... concentrations of total arsenic above 150 micrograms per litre as being "very high". To be consistent with

Ministry of the Environment

133 Dalton Avenue
P O Box 820
Kingston ON K7L 4X6

Ministère de l'Environnement

133 avenue Dalton
C P 820
Kingston ON K7L 4X6

Ontario

August 21, 1998

Re: Deloro Environmental and Health Risk Assessment

Dear Deloro Resident:

The Ministry of the Environment is undertaking an environmental and health risk assessment in the community of Deloro, in coordination with the Hastings and Prince Edward County Health Unit and the Ministry of Health

Work includes collecting samples of soil, plants, outdoor and indoor air, and drinking water We are testing for arsenic, heavy metals, radionuclides and radon gas You may also be asked to participate on a voluntary basis in urine sampling, to test for the presence of arsenic.

This consultant from Goss Gilroy Inc. has been authorized to carry out part of this work on our behalf. We encourage you to participate in this village-wide assessment. We need to gather as many samples as possible to make sure the results of the study are accurate and meaningful for everyone.

The health risk assessment should be completed by early 1999. At that time, we'll provide the results of the study, explain the findings, and answer your questions

If you have questions about the study, or any of the sampling over the next two months, please feel free to visit or call the CH2M Gore and Storrie Ltd. trailer located at the Deloro Mine Site. This will be open from Monday to Friday from to 8:00 a.m. to 5:00 p.m The telephone number is 472-1820

Jim Ritter, Regional Project Engineer
Ministry of the Environment
Kingston
(613) 549-4000

Ministry of the Environment

133 Dalton Avenue
P O Box 820
Kingston ON K7L 4X6

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Ontario

1-613/549-4000 1-800/267-0974 Fax: 613/548-6908

November 9, 1998

To the Occupant

Dear Havelock Resident:

Re: Deloro Mine Site Rehabilitation Project
Deloro Village Environmental Health Risk Study

The Ministry of the Environment is seeking your assistance to aid your neighbours in nearby Deloro in the completion of an Environmental Health Risk Study. Although the focus of the study is the community of Deloro, information collected needs to be compared to a "reference community" where the residents are not living close to the contaminant being studied. Havelock has been chosen as this "reference community".

On the 20th of October 1998, I met with your local Medical Officer of Health, Dr. Garry Humphreys, and the Havelock, Belmont & Methuen Township Council. The voluntary participation of Havelock residents in the "reference community" portion of the study was endorsed by Dr. Humphreys and the Council as a means by which a neighbour could lend support to a neighbour.

The environmental health risk study is an important part of the final assessment, clean-up and containment of contaminated materials at the former Deloro Mine Site. The study is looking at whether contaminants from past mining and refining activities at the site are present in the community of Deloro. It will also determine the likelihood, if any, of health effects from these contaminants on Deloro residents. The Deloro study is now well underway. The Ministry of the Environment is working closely with its consultants, the Ministry of Health, Medical Officers of Health, and a committee of Deloro residents.

The survey of Havelock residents will consist of two parts: a confidential health-related interview (about 15 minutes in length), and a next-morning urine sample collection (using a simple kit with instructions that are explained and left with the householder by our interviewer). The urine analysis will only test for the presence of arsenic in each participant. There will be no analysis for any other elements. Participants in the survey will receive the results of their own analysis.

communications to residents and physicians Goss Gilroy Inc. should identify total arsenic concentrations in urine that exceed 150 micrograms per litre as being above the 'normal range.'"

Our response: We agree. Revisions to our Report will be made in this regard.

√ - "In sections 4.2, 4.5, and 5.0 of the report Goss Gilroy Inc. characterizes ... a speciated arsenic concentration of 15 micrograms per litre in urine is cited as being significant in the report. Communications to residents and physicians was based on a speciated arsenic concentration of 20 micrograms per litre. Goss Gilroy should use 20 micrograms per litre as being the upper limit of the 'normal' range." **Our response**: We agree. Revisions to our Report will be so made.

√ - "In sections 4.2, 4.5, and 5.0 of the report Goss Gilroy Inc. characterizes ... the report identifies five lifestyle indicators and eight environmental factors surveyed in Deloro and Havelock yet there are no accompanying statements explaining why the criteria were selected. The reader is left to assume that ... have potential impacts on levels of arsenic in the body ... but not explored with respect to exposure to arsenic."

Our response: The variables noted in the study are the normal factors to be considered in a health risk study. However, their relationship with arsenic is unknown, therefore, they may not be confounders in this epidemiological study. The number of respondents in the study were too small to explore these relationships in more detail.

√ - "In section 4.4.2 of the draft report it is stated that the majority of residences surveyed had vegetable gardens, however, the percentage of residences in Deloro ... is identified as 45%. That cannot be said to constitute 'a majority.'"

Our response: The overall percentage is still a majority. However, to avoid further confusion on terminology, we will slightly adjust the final text.

√ - "In section 4.4.4 of the report it is noted that 30% of the residents in Deloro had wells ... seems to contradict information collected through other means ... ten private wells ... study."

Our response: Both statements can be correct, as one is based on residents, and the other on households. However, to be absolutely clear for the final text, we will adjust our wording to avoid any further confusion.

√ - "Comment 1: Community awareness may affect the results of the study. Knowledge ... (If behaviour has been altered, how long does it last? Factors affecting altered behaviour include demographic changes, and individual and community perception of risk) ... Warnings ... Fact sheets." Also, "Comment 19: this may not be true (as the study addresses current exposure) ... ."

Our response: We agree with the Comment 1 observation from the literature. It is possible that a community with a known 'contaminated environment' will change their behaviour to lessen their exposures and thus their risk to various 'contaminants'. Our

study was not designed to measure behavioural changes over time, nor to measure the affects of knowledge awareness campaigns, warnings or fact sheets. Very simply, the biological monitoring of urinary arsenic in community residents in conjunction with the administration of an environmental health risk questionnaire and analysis of the collected data has resulted in a statistically precise picture of the levels of urinary arsenic and other risk factors in this population at the time the samples were collected - or, as noted in Comment 19, "the biologic monitoring for arsenic addresses current exposure" (we agree). We will add the appropriate clarifying points to our final revision.

√ - "Findings (page 3-2) Urinary Arsenic Results (page 3-=2). ... Speciated arsenic is appropriate for assessing exposure to arsenicals. Mass per unit volume, however, may not provide appropriate results because of dilution. A marker such as creatine should be included in the analysis to assess dilutenes of the urine." Also, "The report indicated the analysis of urine creatinine. However, no data were given. For those samples containing very high levels of arsenic, was the creatinine concentration also high, indicating that the sample was concentrated? ... Also, include creatinine data. Re-analyze some of the data using arsenic/creatinine ratio, especially those high arsenic data points. ... Also, General Comment 3: Factors such as diluteness ... can effect the arsenic level reported in urine ... ."

Our response: Our first internal results from MAXXAM for the biological monitoring samples did contrast the analysis of total/speciated urinary arsenic - using urine creatinine - with that of the more traditional presentation of results in μg/L (without urine creatinine). These results were examined by the internal team, including the MOE, and found to be quite similar in magnitude/interpretation. Following this, the literature review for urinary arsenic-based studies also found many previous studies using the traditional method of analysis. It was then decided by the Technical Steering Committee to proceed solely with the traditional analysis for the purposes of our health risk study. Therefore, we do not recommend that the creatinine marker be used in the analysis of our Report, primarily, because it will not change the findings of our study.

√ - "Comment 26, 27, General Comment 3 ... "

Our response: Similar remarks to other comments above. We do not know the specific exposure rate to arsenic. Our study is not a time study, per se, but a snapshot, a one-time cross-sectional health risk study that addresses with current methods (urinary-arsenic monitoring) and epidemiological approach (environmental health risk questionnaire) the health status of a population of residents possibly exposed to arsenic.

√ - "General Comment 4: Herbal medications and teas containing metals including arsenic are becoming more prevalent and can cause elevated urinary arsenic levels and adverse health effects."

Our response: We agree. We did measure the use of herbal medications through the health risk questionnaire administered to all residents. However, teas were not included in our coverage.

Appendix D: Copies of Consent Forms

GOSS GILROY INC.
Management Consultants
Conseillers en gestion

Consent Form - Child and Youth (under 16)
Deloro Village Environmental Health Risk Study

Project Contact: *Celine Pinsent, Survey Manager*
Senior Consultant, Goss Gilroy Inc.
900 - 150 Metcalfe St., Ottawa, ON K2P 1P1
1-800-611-0511

I understand that the purpose of the present study is to measure the health of residents of the village of Deloro, Ontario. By conducting this study, the researchers will attempt to measure the impact of any environmental risks that may be present in the area, in particular the exposure to arsenic in the environment.

In order to understand possible impacts, the researchers, Goss Gilroy Inc., will be conducting an interview with one of the adults of my household. This interview will cover topics such as the health of my family as well as general information like type of employment, diet, and daily activities. If convenient for household members, this interview will take place in my home. As well, the researchers will require that my child provide a urine sample for analysis. He/she will be able to provide this sample in my own home and the researchers will pick it up for analysis.

I understand that my child's participation in this study is voluntary. He/she may decide to withdraw or refuse to answer certain questions without penalty or explanation. The researchers do not expect any risk associated with participating in this study.

I understand that information collected about my children will remain strictly confidential. Information will only be available to those researchers involved in the study. It will not be possible to identify individuals in any publications or reports resulting from this study. All identifying information will be destroyed 12 months after completion of the study.

I understand I will receive my child's results of the urine analysis. These results will be conveyed to me by local Ministry of Health officials. If results are outside of the normal range, I will be advised to consult with my physician.

As this child's parent/guardian, I will sign two copies of this consent form. I will provide one copy for the researcher. I will keep the other copy for my own files.

I understand that I may contact the Survey Manager, Celine Pinsent, at the project office at 1-800-611-0511 to obtain additional information.

Child's name: _____

Child's birthdate: _____

Parent/Guardian Signature: _____

_____
(Please print name on this line)

Date: _____

Address: _____

_____

_____
(Postal code)

Phone Number: _____

GOSS GILROY INC.
Management Consultants
Conseillers en gestion

Consent Form - Adult (16 and over)
Deloro Village Environmental Health Risk Study

Project Contact: *Celine Pinsent, Survey Manager*
Senior Consultant, Goss Gilroy Inc.
900 - 150 Metcalfe St., Ottawa, ON K2P 1P1
1-800-611-0511

I understand that the purpose of the present study is to measure the health of residents of the village of Deloro, Ontario. By conducting this study, the researchers will attempt to measure the impact of any environmental risks that may be present in the area, in particular the exposure to arsenic in the environment.

In order to understand possible impacts, the researchers, Goss Gilroy Inc., will be conducting an interview with one of the adults of my household. This interview will cover topics such as the health of my family as well as general information like type of employment, diet, and daily activities. If convenient for household members, this interview will take place in my home. As well, the researchers will require that I provide a urine sample for analysis. I will be able to provide this sample in my own home and the researchers will pick it up for analysis.

I understand that my participation in this study is voluntary. I may decide to withdraw or refuse to answer certain questions without penalty or explanation. The researchers do not expect any risk associated with participating in this study.

I understand that information collected from me will remain strictly confidential. Information will only be available to those researchers involved in the study. It will not be possible to identify individuals in any publications or reports resulting from this study. All identifying information will be destroyed 12 months after completion of the study.

I understand I will receive my individual results of the urine analysis. These results will be conveyed to me by local Ministry of Health officials. If results are outside of the normal range, I will be advised to consult with my physician.

I will sign two copies of this consent form. I will provide one copy for the researcher. I will keep the other copy for my own files.

I understand that I may contact the Survey Manager, Celine Pinsent, at the project office at 1-800-611-0511 to obtain additional information.

Signature: _____

_____
(Please print name on this line)

Date: _____

Address: _____

_____

_____
(Postal code)

Phone Number: _____

Appendix E: Goss Gilroy's Memo Response to Reviewers' Comments

All information from the interview and urine samples will be used only by members of the research team, and will remain strictly confidential. All personal identifying information will be destroyed when the study is completed. Only general, combined information and statistical summaries will be included in the final study report.

Results from this Deloro - Havelock comparison will feed into the Community of Deloro health risk assessment, and will be considered in the development of the final site clean-up plan. The Deloro environmental and health risk study should be completed by early 1999.

All individuals in a household are asked to participate in the study. **Your participation in any or all aspects of the Havelock survey is entirely voluntary**. However, your participation is vital to the success of the overall study.

The participation of you and your family is therefore kindly requested. Ms. Celine Pinsent, the survey team manager from Goss Gilroy Inc., will be contacting you shortly to seek your formal consent to the survey. Goss Gilroy Inc. is the consultant that has been authorized by the Ministry of the Environment to collect household data from residents in Deloro and Havelock. Ms. Pinsent will be pleased to further explain the study and answer any questions you may have. You can also direct questions to me at the Ministry of the Environment, 1-800-267-0974, or to Dr. Garry Humphreys at the Peterborough County-City Health Unit, (705) 743-1000.

Your assistance in completing this study would be much appreciated.

Yours truly,

J.G. Ritter
Regional Project Engineer
Assistant Director's Office
Eastern Region
JGR/gl

Fish Consumption Prior to Urine Collection

Were any of the following consumed on the day prior to urine collection?

Type Fish Eaten	Yes	No	***If Yes,*** who ate it?
Fillets or Steaks - fresh, frozen, salted (cod, halibut, sole, haddock, ocean salmon etc.)			
Frozen Fish Sticks or Fish Dinners			
Shellfish (lobster, crab, shrimp, scallops, oysters, clams, mussels)			
Canned Fish (tuna, salmon, sardines)			
Whole Fish - fresh or frozen (herring, mackerel, sea smelts)			
Caviar/fish roe			
Local Fresh Water Fish			
Other: (Please specify) a. _____ b. _____ c. _____			

Thank you very much for your assistance. We greatly appreciate your time and cooperation in helping us.